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The Outlook

Danger at Blackpool

WHEN people go away for their holidays they want to forget the war. For many families holidays are rather rare and very precious, since, for the rest of the year, they live in an atmosphere of unremitting work making the tools of war as well as fire-watching or other civil defence duty. Is it fair, then, that they should be bothered on the sands of Blackpool by unthinking R.A.F. pilots diving fighters at the beach or flying low in formation over the shallow water in which children are paddling?

On the Correspondence page we publish a letter from a reader who supplies particulars of these actions. This reader is an "A" licence pilot who was on holiday there for a week, and he writes, not in the spirit of criticism of a man who wants a "safe" war, but to enquire whether all this is really necessary. Everyone knows and realises that the civilian's life must be risked in this war just as much as that of any man in any of the three Services—but not one life should be risked unnecessarily.

Has there not been enough loss of life unnecessarily at Blackpool? The recent collision of two aircraft over the Central Railway Station caused many deaths, all of them avoidable by the simple expedient of insisting that there be no flying over the town or other crowded part.

We do not think that young airmen, training to fight in a conflict which will require all their daring as well as their skill, can reasonably be expected to refrain from stretching both qualities to the limit in their practice, and they naturally feel tremendous exuberance when in charge of a thousand horse-power engine. But, despite the general cheapness of human life at present, we must ask that they do not endanger the life of any person unnecessarily. And we think that it is the responsibility of the station commander to see that this is observed by strict insistence on low flying being done over the sea or over land not occupied by crowds.

Mr. Churchill on the Air

IN his review of the war in the House of Commons on September 9th, the Prime Minister gave some interesting information about certain features of the air war which are not generally known, and also made one quite significant correction of a remark which, had it not been corrected, might have set the hopes of the man in the street on a wrong tack. The Prime Minister spoke of "that broadening stream of heavy bombers now acting against Germany night after night which will play a decisive part, or one of the decisive parts, in the final victory." But for the correction the belief might have got abroad that the Prime Minister had given up hope of land operations against Germany (in which case why should Lord Beaverbrook be always harping on the output of tanks?) and had come to the belief that strategic bombing by itself would finish the war. In the same passage he mentioned the importance of "the spacious airfields which we have constructed and which we are expanding there (i.e., in Iceland) and in Newfoundland." Incidentally, the use of the word "airfield" by the Prime Minister may be noted.

Mr. Churchill confirmed General Wavell's opinion that our stand in Crete had saved Syria and Iraq for us. "The German parachute and airborne corps which, no doubt, was to have operated in Iraq, and which would have been assisted on their journey across Syria

by the Vichy French, had been largely exterminated in the Battle of Crete. Over 4,000 of these special troops were killed, and very large numbers of carrier aircraft were destroyed. This specialist corps were so mauled in the ferocious fighting that, although they forced us to evacuate Crete, they were themselves in no condition for further operations."

Other interesting scraps of air information in the Prime Minister's speech told us that "new and brilliant" tactics have been developed by the Coastal Command and the R.A.F. bombing squadrons in dealing with enemy shipping; that almost every night 30 or 40 enemy aircraft drop mines in places likely to catch our shipping; and that in the Middle East we have within the last year built up an Air Force almost as large as that which we had in Great Britain when the war began. These items were scattered throughout Mr. Churchill's speech, and we have thought it would be of help to our readers if we picked them out and presented them together.

Cockpit Trouble

CIVIL flying accidents, like the poor, are always with us. There is also another characteristic in common, for the fact that some people are condemned to a poverty-stricken existence is as undesirable as the violent deaths of others in air accidents. We have had a statement in the House by the Air Minister on the first two of the recent three Atlantic Ferry accidents. These two accidents, which both occurred to four-engined aircraft leaving this country, took 44 valuable lives, of which the most distinguished was that of the Canadian, Mr. Arthur Purvis, chief of the British Purchasing Commission in U.S.A.

Both these accidents were, to judge from the statement, quite avoidable. The first was caused by being off course and flying into a mountain in conditions of poor visibility. From facts known to us, the aeroplane must have been flying at the low altitude of less than 3,000ft. If it had been up at only the modest height of 5,000ft. it would have been safe, even though it was off course, for there is nothing in the British Isles which it could have hit. Furthermore, there is no reason apparent why it should not have been flown at this height.

In the second accident the pilot used the wrong runway on the aerodrome, not the one which he had declared his intention of using. Then, in the take-off, he let the aeroplane leave the runway for the grass. Apparently this retarded it so much that it left the ground at the end of the aerodrome little if at all above its stalling speed. It subsequently crashed just outside the aerodrome. Neither of these two accidents should have happened. Life is always supremely valuable and must never be thrown away, but the loss of highly qualified men in wartime is particularly grievous.

WELL NAMED: This picture gives an excellent impression of the new Lockheed Lightning single-seater fighter now being produced for the R.A.F. Officially known in America as the P-38, it is credited with having been clocked in level flight at 458 m p.h. Powered by two 1,150 h.p. liquid-cooled Allisons, it has a service ceiling of well over 30,000ft and is said to have an exceptional high-altitude performance. All its armament is mounted in the nose of the nacelle.

War in the Air

Berlin's Heaviest Raid : Hudson Captures U-boat : Turin Attacked Again

CONFLICTING news has been coming through about the German attempts to encircle Leningrad. The Germans have stated that "the biggest masses of aircraft ever known" were being used against the Russians in that sector. The Russians report air raids on the city, and though they claim that most of the attackers were driven off, they admit that some machines got through and dropped H.E. and fire-bombs on different parts of the town. Several fires broke out as a result. Much of Leningrad consists of wooden buildings, but they are built of heavy timber, which is not so easy to set alight. Commentators believe that the Germans do not wish to destroy the city as they have destroyed Warsaw and other places, but hope to capture it fairly intact, both on account of the works and stores in it, and also as winter quarters for part of their armies. The High Command is now evidently reconciled to the idea of prolonging the campaign in Russia throughout the coming winter. "Reconciled" would probably be too strong a word to express the feelings of the German private soldier.

Meantime, in the central sector, Marshal Timoshenko has gained a victory at Elnya, which is regarded as of some importance. He could scarcely have done that unless his Air Force were in good trim.

The R.A.F. continues to help Russia to the best of its ability by bombing important targets in Germany and occupied territory. Last week the synthetic rubber factory at Huls in the Rhineland was mentioned. Some nights later Berlin received the heaviest raid which it had ever experienced, while other places were visited the same night. The R.A.F. lost 20 bombers that night, but it is hoped that some really hampering damage was done to military targets in Berlin and the other towns.

Over Berlin

CREWS coming in from the west saw first the chain of lakes bright in the moonlight and then the River Spree and the streets of Berlin. "You could see the streets and the street crossings," a gunner said. "You could easily identify the bigger buildings. It was so bright that you could even make out traffic moving along some of the streets. I expect most of it was fire engines. Soon raging fires made even better landmarks as the bombers came in thick and fast. Buildings and streets away from the fires were glowing red in the light of the flames." "We flew right over the centre of the city," an observer said. "The *flak* was there but we have been shot at worse in other places. One of the new high explosive bombs went off as we were going in and another as we were coming out. Both of them went off with a terrific red flash which seemed to hang in the air for a few seconds." Many crews asked whether the Russians were over Berlin as well. "We should like to meet them there," said one pilot. "I went in from the east so the Germans may have thought I was a Russian. I hope they did. Any way, Berlin was under such heavy fire that the Germans may well have thought that there were two air forces going for them."

One of the most dramatic incidents of the war has recently been made public, namely, the capture of a U-boat by a Hudson aircraft. The Hudson went out on Atlantic patrol early one morning and presently sighted the U-boat awash. The pilot dived, and so did the U-boat. The Hudson released a salvo of bombs, and the submarine came to the surface, evidently damaged and unable to remain below. The German sailors streamed out of the conning tower, apparently about to man their gun, and the Hudson dived five times on them, firing its machine guns. On the fifth dive the Germans held up a white shirt in token of surrender, and the Hudson thereupon ceased fire. The entire crew of the submarine crowded into the conning tower, some 30 to 40 of them. The crew of the Hudson could see their faces as the machine flew low over its capture, "and a very glum lot they looked," remarked the pilot. The U-boat was slightly down by the bows with waves breaking over her decks. A message was sent

SAND BLASTED : The tail holders are not to be envied of their job while the Allison engine of a Tomahawk is run up on the desert.

WAR IN THE AIR

off to the Hudson's base, and the aircraft continued to circle its quarry with guns trained on it. That went on for three and a half hours, and then a Catalina arrived to relieve the Hudson. Other Coastal Command machines in the vicinity were also directed to fly over the U-boat from time to time. Just before darkness fell one of H.M. ships arrived on the scene, and then the Catalina had to go home, but another flying boat of the same type took over before dawn. But a gale was blowing and boats could not be launched to put a boarding party in the U-boat until 40 hours after the arrival of the first naval ship. Finally, the submarine was taken in tow and brought into a British port.

Evasive Action

HUDSONS are machines which were not originally designed for trouble, but seem to delight in getting into it. Giving an account of a scrap between a Hudson and a Heinkel, a member of the Hudson's crew said: "Our pilot is famous for his evasive action, which he practises on every possible occasion. He got a chance to carry it out in earnest when the Hun made a last desperate effort to bring us down. The Hudson did everything but loop-the-loop. All articles that were not clamped down 'took off' by themselves and began to float around the cabin. A camera, a box of biscuits and a bottle of milk were suspended on a level with my head. This phenomenon of evasive action is astounding. It is caused when the aircraft hurtles down to the 'deck' so swiftly that articles which have been thrown towards the roof never have time to reach the floor, but continue to fall with the aircraft until its speed is checked. Then they hit the floor with a wallop. The camera was the craziest of the 'floating' articles. I watched it wallow about until it hit the gunner a crack on the head. He got a bad shock, as he thought he had been struck by a bullet."

The Squadron Leader pilot of the Hudson which "arrested" the U-boat.

CLOSE CO-OPERATION: A Catalina flying boat has taken over from the Hudson which attacked and damaged the U-boat, and is circling overhead while one of His Majesty's ships is standing by with guns trained to see that the submarine does not play any tricks.

Half-hearted Huns

DURING the first half of September the *Luftwaffe* made no determined attacks on Great Britain, though it may do so at any moment. Russia seems to be occupying the full attention of Göring and Co. for the time being, and the losses of German bombers there have certainly weakened their striking power. This consideration will probably not hold good when the winter sets in and things grow comparatively quiet on the Eastern front. In the meantime, a few individual bombers have been rather cautiously approaching the coasts of Great Britain and dropping a few bombs, which sometimes kill or wound a few people. A few of these marauders get caught by our night fighters. In all probability they are manned by young crews who make these half-hearted raids as a sort of training exercise.

Another interesting incident has been the destruction of a *flak* ship by a single Spitfire armed with cannon and machine guns. The Spitfire was on a reconnaissance flight, when the pilot saw three *flak*-ships near Ostend. He dived on them and, while still firing his first burst, saw one of the ships explode and the superstructure disintegrate, throwing pieces all around in the air. His comment on his return was: "It is highly probable I hit the magazine. I broke off the engagement while I was still 200 yards away from the wreckage."

Four-engined bombers of the R.A.F. paid their first visit to Italy on the night of September 10th. Stirlings led the attack and Halifaxes as well as two-engined machines came later. Turin was the target, chiefly the Royal Arsenal, which turns out guns, shells, tanks and many other implements of war. The arsenal covers a huge area, and has been attacked before, but is not to be completely liquidated in one raid. On this raid great damage was done in parts, and many fires and

The sergeant rear gunner of the Hudson made the U-boat crew behave.

A HUDSON AT WORK: This artist's impression does not relate to the incident depicted on the opposite page, but it shows what might have happened to the U-boat if the white flag had no been displayed

explosions followed the fall of the British bombs. An important railway yard was also attacked. The Air Ministry has admitted the loss of four of our bombers, but the Italians, reporting raids on Turin, Genoa and Messina in one communiqué, only claimed that one British raider had been shot down.

A pleasing ceremony has taken place at Malta. The Anglo-Maltese League presented two shields to Air Vice-Marshal Lloyd for the Royal Air Force and Fleet Air Arm. They were inscribed: "In the name of the people of Malta to the Royal Air Force and Fleet Air Arm in token of appreciation and gratitude for brilliant services rendered in the defence of these islands." In reply, the A.O.C. remarked: "We have been called the Knights of the Air, a high compliment. We hold this in common with the Knights of St. John. They cleared the seas of the scourge of piracy. Our task is to clear the sea and the air of the scourge of dictatorship, and we will."

President Roosevelt has made a striking broadcast to "My fellow Americans" on the attack by a U-boat made on the U.S. destroyer *Greer*. His concluding sentence was: "Our patrolling vessels and aeroplanes will protect all merchant ships—not only American ships but ships of any flag—engaged in commerce in our defensive waters." These words mean considerable help to Britain in the Atlantic.

In the course of a distinctly lively debate in the House of Commons, the Prime Minister announced that the Minister of Aircraft Production had been ardently at work sending hundreds of fighter aircraft to Russia, many of which had already got there.

BRITISH AIR LOSSES TO SEPT. 13th.

		Over Fighters	G.B. Pilots	Over Continent Aircraft	Middle East Aircraft
Sept.	7	0	0	26	1
"	8	0	0	2	1
"	9	0	0	0	0
"	10	0	0	6	2
"	11	0	0	3	0
"	12	0	0	3	0
"	13	0	0	0	4
		0	0	40	8

Totals: Northern Area, 2,695; Middle East, about 385.

ENEMY AIR LOSSES TO SEPT 13th.

		Over G.B.	Over Continent	Middle East
Sept.	7	0	6	2
"	8	1	0	7
"	9	0	0	0
"	10	0	0	1*
"	11	0	0	2
"	12	2	1	1
"	13	0	2	2
		3	9	15

Totals: Northern Area, 5,309; Middle East, over 2,108.

*Not counting many hit on the ground.

R.A.F. Wing in Russia

IT has been announced that a complete self-contained Wing of the R.A.F. has reached Russia. It is left for the Germans to find out what is the strength of this unit, for a Wing may contain a quite undefined number of squadrons. Likewise, it has not been stated whether it consists of fighters or bombers. The main point is that it is self-contained, as Russian spares would not fit British machines, nor would the petrol which the Red Air Fleet uses be suitable for British engines. Russian mechanics would not be able to maintain our aircraft.

The German thrust against Murmansk is evidently intended to interfere with British help reaching Russia that way, and the attack by the Royal Navy and the raid by the Fleet Air Arm on the enemy's supplies and sea communications at Bodo, on the Norwegian coast, was probably connected with the same plan of operations. The German armies in the north would obviously benefit by supplies brought by sea, and the Royal Navy is interfering with those supplies. Iran now offers a new route for supplying Russia, but it needs development, more rolling stock, etc., and that sort of thing takes time.

The Admiralty has published a tale of tragedy and gallantry about a large convoy which was attacked in the Atlantic some months ago. Both U-boats and Focke-Wulf Condors took part in the attack, and both aircraft and seacraft did damage. Three ships were sunk by torpedoes, four by bombs, while another was so damaged by a bomb that it afterwards foundered in a gale. One of the Condors is believed to have been damaged by the fire of the ships; at any rate, one German aircraft was reported to have crashed later in the day. The great majority of the convoy reached port safely.

AFTER THE WAR

Major Robertson Taken to Task

By "AIR VICE-MARSHAL"

IT is important that people connected with aviation, and officers of the Royal Air Force in particular, should now begin to think clearly about the part that air power must play in the restoration and maintenance of world order after the war. It is more unfortunate that the writer of an article bearing the above title in the issue of *Flight* of August 28th should have betrayed a conception of British air requirements in the post-war period which is not only pre-1938 but positively pre-1914 in character. In this article, which contains much that is useful, Maj. Robertson begins a summary of "Britain's Necessary Armaments" with the assertion, with which no one will quarrel, that we must certainly maintain a Navy, on which our very life depends. He goes on to say that our needs as far as the Army are concerned are served by a small, very-well-equipped Regular Army, capable of very rapid expansion through the agency of the Territorial Army. That, again, is a reasonable statement—though from what follows it appears that he is by no means clear as to what we need this Army for. When he turns to the Air Force, his first concern appears to be, after the maintenance of a separate Fleet Air Arm (which no one contests), the creation of an Army Air Arm "suitable to carry out all the operations required by the Generals"—a proposition which is in itself highly controversial and, in this wider context, strangely irrelevant. It is a sorry symptom that, after the experience of the last three years, any writer on major military policy should place in the forefront of the Empire's air requirements a highly partisan proposition of this nature. He goes on to state the obvious truth that Fighter Command must be kept strong enough to guarantee the integrity of the British Isles against air attack, and that it should retain complete charge of all the various components of air defence. Overseas Commands are dismissed with the statement that they "must be considered in the light of local conditions."

A SUBJECT such as the future of Air Power has many sides, and it is not to be expected that anything even approaching agreement should exist at this stage. The article by Major F. A. de V. Robertson, V.D., in our issue of August 28th entitled "After the War," expressed one view. That view does not appear to be shared by the Air Ministry, who have sent us the following contribution, which, presumably, represents the considered opinions of the Air Council. We have not been supplied with the identity of "Air Vice-Marshal" but have merely been informed that he is "a highly-placed officer of the R.A.F." In the circumstances we have departed from our usual rule not to publish anonymous contributions.—Ed.

Persuasive Power

But it is when the writer turns to Bomber Command that he really takes one's breath away. He starts by saying it must be sufficient to reinforce the Navy or Army; says it must "maintain its function as a pool or a reserve"—whatever that may mean; but then goes on to express doubts as to whether we "need to maintain a strong, independent striking force" (that meaningless and misleading word, "independent"); and sums up by saying that "It may well be that if our coasts (*coasts*, mark you) are safe from air attack and our Army and Navy can count on really adequate support from the air, our purposes will be adequately served"!!

This is really a masterpiece of muddled thinking. In an earlier passage Maj. Robertson rightly points out that the destruction of the Nazi tyranny and the banishment of fear from the lives of all men means, first and foremost, the disappearance of the *Luftwaffe* as a threatening force, and queries whether the tragedy of Czechoslovakia and the humiliation of Munich would have occurred but for the striking power of the German Air Force. But he overlooks the fact that not only the *disappearance* of the *Luftwaffe* is an essential to peace, but also the *prevention of its resurgence;* German armed might disappeared after 1918. At the same time, he admits the decisive influence already exerted by a powerful air striking force as a backing to diplomacy; yet from the context it is clear that he envisages post-war conditions in which we have still powerful potential enemies in Europe since otherwise why keep Fighter Command or a very-well-equipped Army capable of rapid expansion? Nevertheless, he proposes to reduce our primary offensive arm to a "pool or reserve" to support the Navy and Army in some unspecified strategy against an enemy whom he evidently credits with sufficient sense to have retained a "strong, independent striking force."

It is unnecessary further to enlarge on this curious conception of the future of British Air Power, except perhaps to enquire whether Maj. Robertson has ever asked himself whether the tragedy of Czechoslovakia and the humiliation of Munich—or, for that matter, the reoccupation of the Rhineland, the rearmament of Germany and the rape of Austria—would have occurred had *we* possessed a powerful air striking force and the moral courage to use it if necessary.

Certainly the Navy and the Army must have air support fully adequate to their needs. Fighter Command must obviously remain and should include, not only the other components of air defence, but also—in common with all other R.A.F. Commands—its own "marines" for the defence of its aerodromes. Overseas Commands must never be allowed to sink back to the ludicrous level of 1939 and their strength must be determined, not only by local conditions (surely we have learnt by now that there is nothing "local" about air power), but by the strength of the enemies with which they may have to contend and the ease and rapidity with which they can be reinforced from elsewhere. But none of these things will avail to retain for us that decisive influence which we and (it may be hoped) the United States must exert if order is to be restored and maintained in Europe after the collapse of the Nazi tyranny, without a striking force so powerful that no one will dare to attack us and our diplomacy will be backed by adequate force—without which diplomacy is powerless, as the late Lord Haldane pointed out about 20 years ago.

Deterrent Action

It is certain that the threat of bombing civilian populations as such will never be part of British policy; but the suggestion that air action against military targets is too slow to "act as a deterrent to a nation which was lusting to embark on a career of aggression" again shows a remarkable confusion of thought. Actually it must surely by now be apparent that bombing of military targets inevitably means suffering and loss of life to the civilian population *once it comes to war between two nations with powerful air forces*. But no nation will "lust to embark on a career of aggression" until it has the force required to give it a chance of crowning that career with success. And the primary task of the Bomber Command in the post-war era will be to ensure that *Germany never again has that force*. When this war has been won—largely by the agency of that striking force whose utility in the post-

(*Continued on p.* 178.)

MECHANICAL FLIGHT COMPUTOR

Flight Planning a Matter of Minutes : New Performance Computor

By HARRY WILKIN PERRY

ALL the mathematical work of making calculations for and during a flight, with the possibility of errors, is obviated by a recently introduced computing machine developed by Librascope, Inc., of Burbank, California. With this new instrument a pilot can determine within a minute or two, right up to the moment of taking off, the most efficient operating conditions for a flight of any distance under any set of variable factors such as gross weight of aeroplane, altitude, air temperature, wind direction and velocity, course of flight, engine revolutions per minute, horse-power, and elapsed time of flight.

Setting the computor to accord with the known existing factors indicates at once on dials the relevant engine speed, manifold pressure, brake mean effective pressure, carburettor air temperature, ground speed, air speed, drift correction, and total fuel consumption for the total flight distance. Thus the pilot can operate the engine at the most efficient speed and power to drive the airscrew at the best speed for maximum fuel economy to make the trip in the scheduled time.

Charts an Alternative

This work, which is essential for flight-planning on scheduled airlines and could greatly improve the efficiency of any bombing operation, can also be done by using charts which make it possible to do the calculations simply by selecting the correct points on graphs and reading off certain figures. An illustration of such a flight-planning chart is shown. This was developed by an engineer of the Civil Aviation Department of Australia for use on a Lockheed Electra. But for much flying no planning, even by chart, has ever been done, and the subject has been rather neglected.

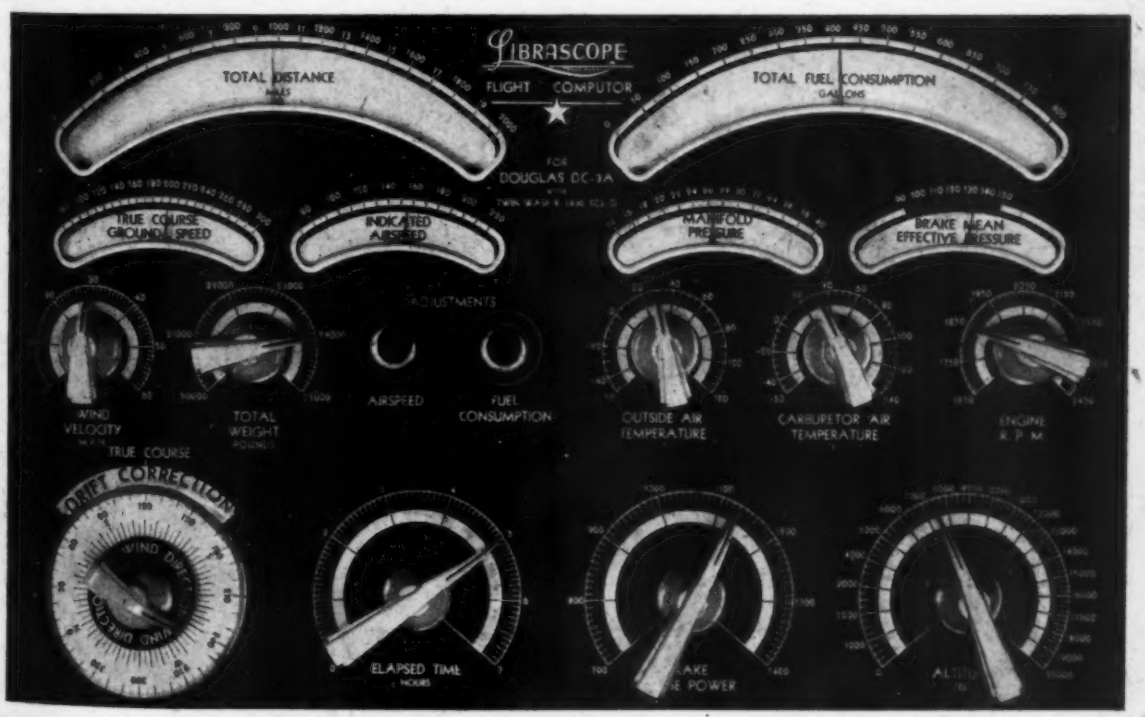
The new mechanical computor makes it possible for any pilot to plan his flight completely and minutely before leaving, providing he has good weather information about wind speed and direction, and the computor will be used on all elaborately equipped airlines. But it will never entirely supersede the flight chart, as this is so much simpler and cheaper and will always be useful for some of the airlines with less "gold braid," such as the taxi and charter companies.

The computor consists of a panel of dials, as shown in the accompanying photograph, a board of adjusting pointer knobs, and internal interconnected mechanism which moves corresponding dial pointers through mathematically predetermined distances to give all necessary information for efficient flight. It relieves pilots and operations departments of the need of making flight-plan computations by methods that require much more time.

Re-planning in Flight

As the instrument is of small size and light weight and is contained in a convenient case, it can be carried in the aeroplane and resettings or corrections made during the flight as wind, temperature, altitude and other variable conditions change. Fuel consumption can be reduced as much as 20 per cent., it is claimed, when the manifold pressure required to maintain allowable mean effective pressure is known for all cruising speeds. The b.m.e.p. indicator gives instant warning if the horse-power necessary to maintain schedule will be injurious to the engine.

By making corrections at check points on the course, the time of arrival at destination will be indicated almost to the second. If fuel is becoming exhausted and a quick decision must be made regarding choice of a landing field, the computor will show the best altitude, horse-power and air speed to cover the maximum distance with the remain-



FACE OF THE LIBRASCOPE FLIGHT COMPUTOR. By setting the dial pointers to various values of power, altitude, time and wind speed, the corresponding figures for ground speed, indicated air speed, total distance, fuel consumed and other quantities can be read off instantly.

MECHANICAL FLIGHT COMPUTOR

ing fuel. Speed of calculation with the flight computor makes possible the adding of corrections for wind direction before the compass deviation and magnetic variation.

For commercial airway operations, a second computor in the despatcher's office is set to duplicate settings of the instrument in the aeroplane in flight, and as the pilot or co-pilot resets his computor according to changes of flying conditions, he notifies the despatcher by radio, and the despatcher resets his instrument to correspond. Thus identical readings are available to both without the need of frequent refiguring of the flight with alterations of meteorological and other factors. Calculation of a full flight plan for a transcontinental flight of 3,000 miles, broken down into a number of legs to show the best altitude, most efficient power for each condition of load, and total fuel consumption and elapsed time, with allowance for changes in weather conditions along the route, can be accomplished in two minutes, the maker asserts.

Two New Computors

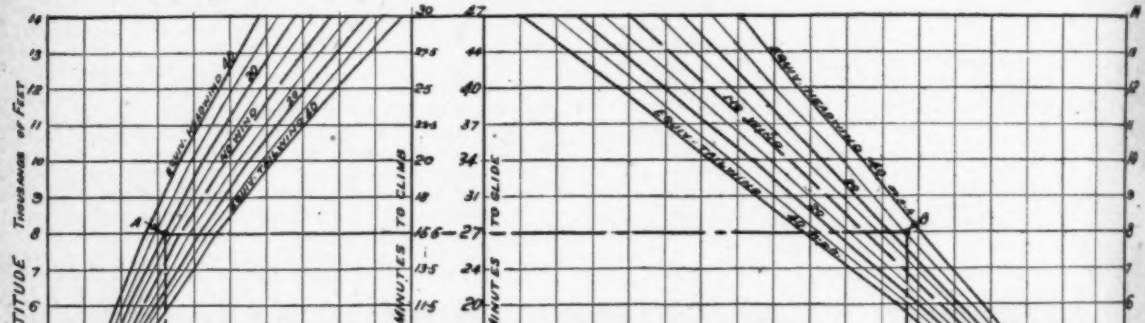
This flight computor was devised and designed by Lewis L. Imm, president of Librascope, Inc., and formerly an inspector of Federal airways with the U.S. Bureau of Air Commerce. Three years ago he turned his attention to the designing of a computor for indicating the correct load balance of transport craft. Now, having perfected the flight computor and put it into commercial production, he is developing two other novel instruments, which will be ready for use in the near future. One is a design computor and the other an air-mass computor. These embody the same simple basic principles of interconnected mechanisms operated by rotating pointers to give mathematically correct readings on dials as in the original Librascope, which has done much to speed up the work of the airline despatcher.

Calculation by Mechanism

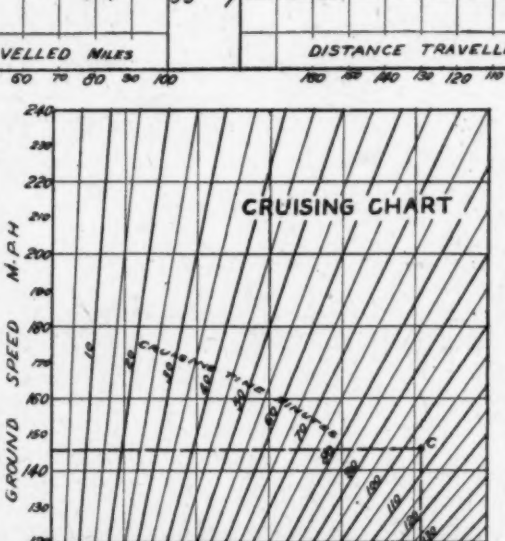
According to advance information, the design computor is based on data developed by wind-tunnel tests of models and will enable aircraft builders to save costs in performance estimation. Setting the pointers for wing area, weight and other design factors will give immediate information on the dials as to load, rate of climb, maximum speed, altitude and other performance variables.

The air-mass indicator is intended for use in indicating probable weather conditions at the point where the instrument is used. It will correlate data as to cyclone movements reported from meteorological stations disposed over a large area.

The underlying feature of all these instruments is that they perform mechanically a series of complicated mathematical operations as the pointers are set. One of the computors gives instant answers to problems involving seven such operations.



CRUISING 250 H.P. 1800 R.P.M.		
DENSITY ALTITUDE	TRUE AIRSPEED M.P.H.	I.A.S. M.P.H.
14,000 ft.	183	145
13	180	146
12,000	178	146
11	176	147
10,000	174	148
9	172	149
8,000	171	150
7	170	151
6,000	169	153
5	167	154
4,000	166	155
3	164	156
2,000	163	157
1	162	158
0000	161	160



FLIGHT PLANNING CHART. The example marked on this chart shows planning for a flight of 350 miles at 8,000ft. "Equivalent headwind" (or tailwind) is determined by triangle of velocities or C.D.C. Using this headwind and altitude, obtain point A on Climbing Chart. Using equivalent headwind and altitude at terminal aerodrome, obtain point B for start of power glide. Remainder is cruising distance, 255 miles. Average headwind is 25 m.p.h. Airspeed at 8,000ft. is 171 m.p.h., so ground speed is 146. Using 146 m.p.h. and 255 miles on Cruising Chart, the cruising time of 1 hr. 45 min. (point C) is found. The flight plan then reads :

	Miles	Time	Gal./min.	Petrol
300 h.p. Climb	32	15.5	@ .67	10.4
250 h.p. Cruise	255	1-45	@ .56	58.8
250 h.p. Glide	63	27	@ .56	15.2
	350	2-28		Net 85 gals.*

* Add extra petrol for warming, taxying, take-off and reserve.

Fourth of the New Series

FRIEND or FOE?

American and German Twin-tail Designs

TWIN-TAIL designs in general may be usefully divided into two main types: those in which the tailplane tips project beyond the fins and rudders and those in which the vertical surfaces are "outrigged" on the tips of the tailplane. The former type mostly have their fins and rudders extended below the tailplane—as though the tips of the latter were threaded through them as shown above—but there are a limited number in which the vertical surfaces sit on top of the tailplane, in which case they are invariably set closer inboard than when "threaded," and they are nearly always strut-braced externally.

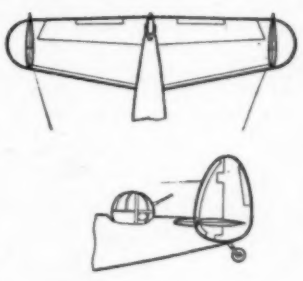
One very useful guide to remember is that, so far, all German twin tails are of the outrigged type, so if one sees a twin-tail machine on which the tailplane tips extend beyond the rudders one can be reasonably certain that it is not an enemy machine. In this, the German designers have shown full appreciation of tail design because the outrigged arrangement has superior aerodynamical qualities.

Most of the British and American twin tails have inboard vertical surfaces, but there are exceptions, notably among certain new machines, about which no details may yet be published. Italian designers, incidentally, favour the "inboard" arrangement, as, for example, on the Fiat BR 20 and the Breda 88.

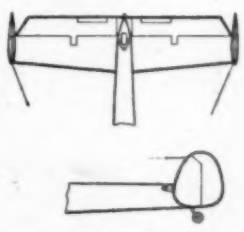
The Lockheed Hudson and the Messerschmitt Me 110, illustrated on this page, provide two very typical examples of characteristic twin-tail assemblies. Not only are the respective *arrangements* of fins and rudders, relative to the tailplanes, characteristic of their nationality, but so also is the *shape* of their outlines. No twin-tail, in the opinion of the writer, can be made to look as graceful as a well-proportioned single fin and rudder tail unit, but the Hudson tailplane has a nice taper and the projecting tips are well rounded, the fins and rudders themselves being egg-shaped. The Messerschmitt tailplane, however, is completely angular, being composed entirely of straight lines and sharp corners, while the vertical surfaces, though devoid of actual corners, are broad and squat, with a flat bottom line. To be fair to the Teuton, however, it must be admitted that subsequent articles in this weekly feature will perforce disclose twin-tail units of British design which are considerably less elegant than that of the Me 110 illustrated here. Mere elegance, of course, is not of primary importance, especially in a fighting machine; its presence or absence, however, does serve as a guide to the spotter when he first glimpses the aircraft he must identify, and so it has its significance to students of this page.

LOCKHEED HUDSON. Oval fins and rudders of high aspect ratio set inboard from rounded tips of tailplane. Vertical surfaces extend below tailplane, which has moderate taper on leading-edge and slight taper on trailing-edge into which elevators are dovetailed.

LOCKHEED HUDSON



Me 110

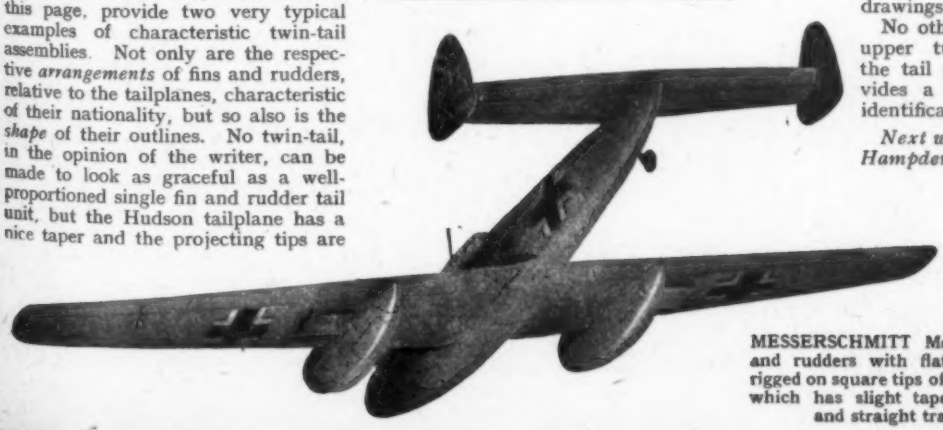


An unusual feature of the Hudson tailplane (though not one likely to be readily seen in flight) is the way in which the elevators, which necessarily lie within the limits of the fins and rudders, are dovetailed into the fixed tailplane, or "stabiliser" as the Americans term it. Trimming tabs are inset on the trailing-edge in the usual way. Both machines have fixed tailwheels.

Although not really a part of the tail assembly, the gun-turret on the Hudson is situated so near the tail that, in the visual sense, it can hardly be excluded, and has, therefore, been shown in the drawings.

No other machine has its upper turret as near to the tail as this, so it provides a certain means of identification.

Next week: Handley Page Hampden and Fiat BR 20.



MESSERSCHMITT Me 110. Squat fins and rudders with flat bottom-line outrigged on square tips of angular tailplane, which has slight taper on leading-edge and straight trailing-edge.

NICE WORK!

Being an Air Gunner's Impressions of a Raid

THE bombers are loaded and ready to go. The grass shows silver behind them, blown flat by the hurrying slipstream. The aircraft roars over the ground, takes off and circles the station. It is still daylight and will be for a while. Fields, grey, green and yellow, shine in warm sunshine. A river, the town where we go to amuse ourselves on evenings of no operations. Another bomber or two drift along in our wake and abeam. The coast with its white line of surf, our silhouette crossing the sand.

The aircraft is rising over the sea. White vapour drifts round us. We are suddenly flying blind in the chill, pressing heart of a cloud. Then, a white, fleecy blanket and the clear sky above us once more. It is not quite dark; there is still a long yellow belt of light. We know we show black against this and good watch must be kept for the foe flying in from the east.

The cloud bank ends. Two or three tiny lights are flashing below. They are ships and we keep on our way. It is too dark for identification, and small ships sometimes carry big guns.

The Target

Now we see what we have been expecting. Ahead, long, straight fingers of light are feeling about in the sky. For some time we drive on through quiet darkness; then a bright light shoots past us ahead.

"What's that?"

"One of their fighters. He's missed us."

Now, a little to port, a great glow lights up the sky. There seem to be an infinite number of searchlights, and among them are flickers and flashes with bright lights slowly descending.

"Oh, boy, there's the target," the young "Second Dickie" sighs gently, "and aren't they busy to-night!"

Straight for that welter we steer. A cold blue beam from a malevolent eye reaches up and lays hold on our aircraft. Another, then three more. We twist and turn. There are sudden flashes; the guns are blazing. Slow, lazy strings of red balls swing up and pass by us to starboard. A bang, flame, puffs of black smoke hanging dense in the searchlights' white glow.

"Heavy stuff, that!" somebody mutters.

Flares float to earth all round us, joined by our own. We are making our "bomb run" now, flying in towards a fire that flares in a deep semicircle. Light flak comes unpleasantly close. The target shows plainly below: a river leads to it; a park, huge buildings, tall chimneys, smoke belching. Something suddenly happens down there. Five flashes, a cloud, a great red mounting explosion.

"Nice work!" shouts someone, and we turn away, heading for home. Daylight reveals a hole or two in our port wing, and the wireless reports: "Last night heavy damage was done by aircraft of Bomber Command to a munitions works in West Germany."

(Top) Captain and Second Pilot of a bomber using oxygen masks during a high-altitude attack. (Bottom left) The bomb-aimer depresses the selector switches as the target is approached. (Bottom right) Suitable provision for a little personal refuelling during a long trip over enemy territory is not overlooked.

AIRSCREW BLADE MATERIALS

An Evaluation of the Merits and Demerits of Wood, Compressed Wood, Steel, Magnesium and Duralumin

By K. B. GILLMORE

IN recent years there has been much discussion as to what is the best material to use for the construction of blades for variable-pitch airscrews. Improved wood of various forms, solid duralumin, solid magnesium and hollow steel have all been used with varying degrees of success, and there has been a good deal of controversy as to whether each of these materials has its own particular place, or whether there is one of them which is definitely superior to all the others.

From the earliest days of airscrew-propelled aircraft, wood seemed to be a naturally suitable material for airscrews with integral-type blades, and enjoyed almost undisputed popularity for many years. Increase in the severity of operating conditions led to a tendency towards the use of harder woods and the introduction of various forms of reinforcing material and protection.

Apart from isolated experiments, such was the situation until shortly after the termination of the last major war. From that time onwards, more attention began to be devoted to the use of various metals as alternative materials, and it is of interest to note that after the year 1920 metal-bladed airscrews were beginning to be used on many occasions when maximum efficiency was required, or particularly arduous operating conditions encountered. In this connection one may cite such examples as the Schneider Trophy Competitions, the world's long-distance record, and numerous air races, etc. It became an increasingly regular thing for private owners to purchase a metal-bladed airscrew upon deciding to enter a machine for a racing event, and the superiority of performance which could be attained despite the, at that time, serious weight increase, was widely acknowledged. About 1925 the first British controllable-pitch airscrew was constructed and flown, and this airscrew had forged duralumin blades.

Meanwhile, in America the growth of airline operations and the use of aircraft on dirt and desert aerodromes had given considerable impetus to the development of the ground-adjustable duralumin-bladed airscrew. When, a few years later, the variable-pitch airscrew was first introduced, it brought with it the necessity for having detachable blades. At that time, this meant of necessity that the blades must be of metal because no means had then been found of holding the root of a detachable wooden blade into a hub, and accordingly these first V.P. airscrews used solid duralumin blades.

THE author of this article is on the technical staff of the airscrew division of the De Havilland Aircraft Co., Ltd. His reasoning and conclusions will be read with interest by all who are concerned with the subject of blade materials, but will not, we believe, be shared by everyone. It must be admitted, however, that he presents the case for duralumin blades in a convincing manner and with scrupulous fairness.

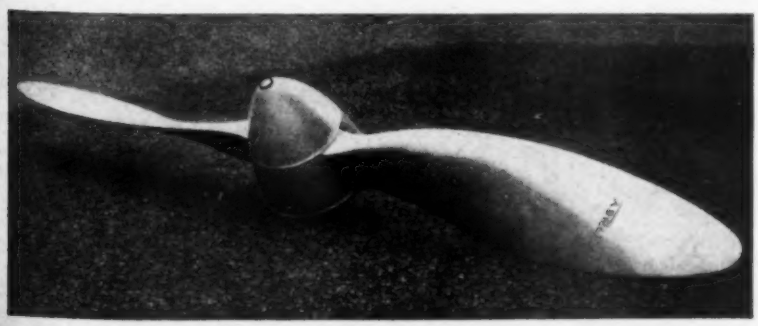
During all this time, when the materials of normal production of fixed-pitch airscrews were wood or solid dural, and all adjustable and variable pitch airscrews were entirely dural, quite a lot of research had been done on the possibility of using hollow steel blades. This work met with a limited amount of success on the smaller sizes of blade, but on the larger sizes trouble was always experienced, either with the welding along the leading- and trailing-edges or else with panting of the sections, giving rise to fatigue cracks in the material. The hollow steel blade was, therefore, not considered as a serious competitor of wood or duralumin at this time.

Shortly afterwards the manufacture of "improved" wood became possible, and it was found that by compressing the wood and impregnating it with a synthetic resin its strength could be raised sufficiently to make it possible to hold a detachable wooden blade in an airscrew hub by means of a screwed-on sleeve. As the dural V.P. airscrews of this period were undoubtedly extremely heavy, the introduction of improved wood was immediately seized upon as an opportunity for lightening the airscrew. Two main systems were used, though various minor alterations to both of them were tried out. The first system, introduced by Schwarz in Germany, consisted of using compressed and impregnated wood for the root of a blade only and attaching an outer portion of lighter wood by scarf-jointing the various planks from which the blade was made up. This system was also adopted by the Airscrew Company in this country.

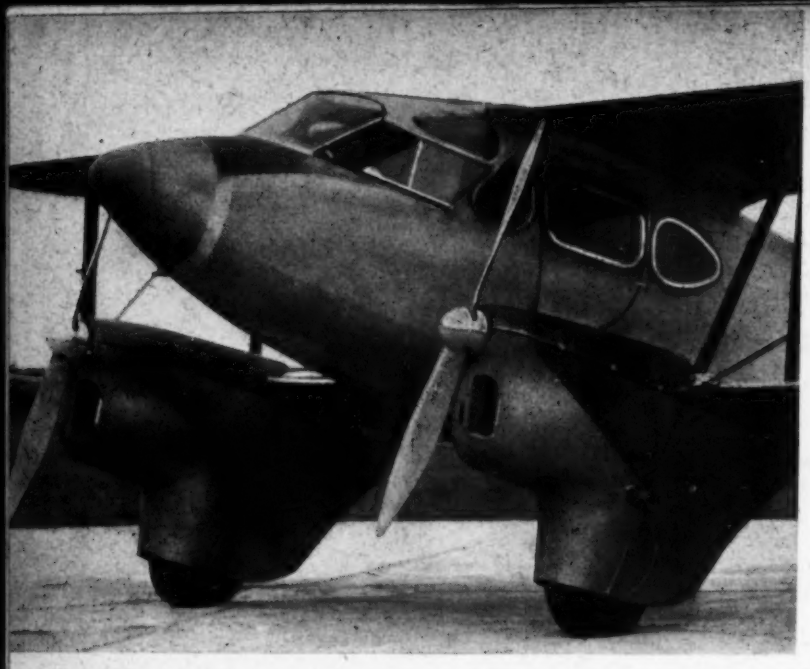
The second method was that developed, also in Germany, by the Heine Company, and consisted of using thin veneers which were impregnated and compressed throughout their length, though the degree of compression and impregnation was varied from the root to the tip of the blade. This system of construction is used in this country by Jablo and Rotol.

At this stage it is not without importance to add that, whilst both these systems of wooden blade construction originated in Germany, there is no evidence to show that they now enjoy any appreciable measure of popularity in that country, and almost all German aircraft are fitted with forged duralumin blades. Furthermore, the

An early wooden four-blader. This particular one was fitted to a B.E.



High efficiency was achieved in the Fairey airscrews designed for the Schneider Trophy seaplanes.



The Fairey-Reed airscrews became popular for racing and for small commercial aircraft.

English company which started out with forged magnesium and followed with low- and then high-density timber for its blades, has now elected to use forged duralumin for its latest experimental products.

Almost concurrently with this development of compressed wood, a lot of work was done on solid magnesium blades. This work, too, was carried out mostly in Germany, where quite a number of magnesium blades were manufactured, chiefly for ground-adjustable airscrews. A number of blade failures, however, occurred, and it appears that magnesium has been abandoned for the construction of airscrew blades, both in Germany and in this country.

In America neither wood nor magnesium made the same progress as they did in Europe, but the hollow steel blade, which had for so long been tried experimentally, was at least beginning to show signs of success. At the present time quite a number of American airscrews of all sizes are being built with hollow steel blades.

It is interesting to review the reasons which led various firms to adopt or reject these alternative methods of construction, and for this purpose the relative merits and demerits of each will be considered in relation to their present state of development.

In a variable-pitch airscrew blade the desirable qualities may be listed as follows:—Efficiency, ease and cheapness of manufacture, reliability, repairability, weight and adaptability to various designs.

These are not necessarily listed in order of importance, as for various purposes different items from this list will become of outstanding value.

On the majority of modern high-speed aeroplanes the airscrew will run at a speed not far below the speed of sound, and it is well known that as the speed of sound is approached, severe losses of efficiency begin to set in. The only effective means of delaying the start of these efficiency losses which so far has been found is to use blades having a very thin section, that is, a very low ratio of thickness to chord. The only material with which these very thin sections are structurally possible is solid duralumin. Wood requires a very considerable increase over dural in order to give sufficient stiffness to prevent flutter, quite apart from considerations of strength in resisting steady stresses.

Solid magnesium approaches fairly closely to duralumin, but this material, too, is somewhat less stiff and less strong, and also suffers considerably from notch sensitivity, so that a greater reserve of strength is required in a magnesium than in a dural blade, and the thickness ratio of sections must suffer accordingly. Hollow steel, although it can use sections of very small wall thickness, requires an appreciable depth of section and an appreciable camber in order to give stability to the thin sheets which must be used to keep weight down. It is, therefore, now generally agreed that the highest efficiency at maximum speed will be obtained by using a solid duralumin blade. It has been claimed for wood that it allows the use of better root sections than can be obtained with dural, but it has now become clear that quite a considerable flare is permissible on dural blades without producing unduly high stress concentrations, so that it is now possible, on a dural blade, to get as good a root section at the point where the blade emerges from the spinner as can be done with wood. Cuffs are an alternative method of obtaining the same result on a dural blade, but seem, on the whole, to be less satisfactory, particularly from the manufacturing and servicing point of view.

Another advantage which is claimed for wood is an improvement in take-

A hollow steel airscrew of Henry Watts design, fitted on an early Moth.

AIRSCREW BLADE MATERIALS

Shaping the compressed-wood blades of an Airscrew Co. propeller.

off performance. In some cases this undoubtedly can be obtained by the use of wider and thicker sections. Frequently, however, the tip speed, even during take-off, is so high that at the large angles of attack associated with take-off conditions, tip speed losses become serious, so that the advantage of the thick section is again reduced. In general, if the diameter of a wooden-bladed airscrew is held down small enough to avoid excessive tip speed losses in level flight, it will show little improvement in take-off as compared with a metal blade.

This state of affairs cannot, of course, be applied indiscriminately to all types, and there will always be special applications, particularly those with severe diameter restrictions and low tip speeds, on which a good performance can be obtained with a wooden blade. These, however, are quite definitely the exception and not the rule.

Ease and Cost of Manufacture

A good deal of development was required in order to obtain a satisfactory technique for the manufacture of forged dural blades, and a considerable outlay is also required in the way of plant. Where this is available, however, the actual manufacturing process is simple, quick and cheap. The process for a magnesium blade is essentially similar to that for dural, though somewhat slower, particularly in the actual forging of the blank.

The Schwarz type of blade is easier to produce than the completely impregnated Heine type, inasmuch as only a small portion of the blade uses compressed and impregnated wood.

In either type of construction, however, a considerable outlay is still required in the way of initial manufacturing plant, owing to the considerable size and number of presses required.

The manufacturing process for a wooden blade is long. The wood must first be seasoned, then the veneers must be cut, impregnated and pressed into planks. The planks must be glued together to form a complete block, and the blade must be shaped, must have the attaching sleeve fitted to the root end, and finally must be covered.

It is possible that for small-scale production the plant required might be slightly smaller than for a corresponding number of dural blades, but for large-scale production the equipment required is comparable with that required for dural, and the production time per blade is very much greater. This is also reflected, of course, in the cost of the blade, and at the present time it appears that a wooden blade costs approximately three times as much as a corresponding dural one if the same large quantities are considered in each case.

A further point which needs consideration is the availability of material. Both duralumin and wood have to be imported, as there is no home-grown timber which is suitable for airscrew blades; nor does there

AIRSCREW BLADE MATERIALS

seem to be any immediate prospect of any home-grown timber being used. Aluminium can be imported in highly refined form, whereas wood, even if imported in the form of veneers, which is less wasteful than importing planks, will not load a ship to its limit, and when the aluminium or the wood veneers reach this country, practically all the aluminium can actually be converted into blades, whereas with veneers there will be a very considerable waste.

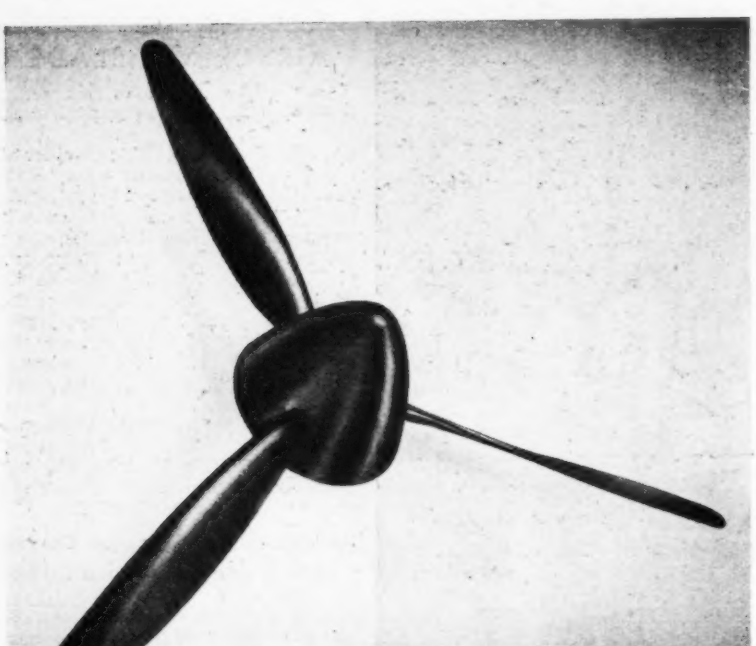
There is no modern experience available in this country of the manufacture of hollow steel blades, but probably it is comparable in time and cost with the duralumin blade.

Reliability and Wear in Service

From the point of view of reliability and wearing properties, solid duralumin has the most enviable reputation. Out of all the many thousands of dural blades which have been used in De Havilland variable-pitch airscrews, not a single shank or tip failure has been reported in service, apart from such obviously accidental damage as that caused by flying into balloon cables. Even if a balloon cable does hit a dural blade, the cable will usually be cut and the damage to the blade will only be such as can be comparatively easily repaired by resmoothing the surface; and even in the comparatively rare cases where a part of the blade has actually been removed, machines have successfully reached their bases.

Under conditions of normal civil operation, the life of a dural blade is extremely long, and there are already many De Havilland blades which have well exceeded 4,000 hours and still show no sign of approaching the end of their useful life.

The position of wooden blades in this respect is very much less satisfactory. Some form of covering is essential in order to resist abrasion from such things as stones thrown up while taxi-ing on an aerodrome, and unless some form of very special protection can be supplied, any really severe damage in flight (such as could be caused by striking a balloon cable or getting a cannon shell through the blade) will inevitably cause a complete failure. Again, if operated on a flying boat, an airscrew has to withstand particularly severe operating conditions, as it may frequently be operating actually in the water if the boat is in a rough sea, when waves may come right over the outboard engine. With a metal blade this will merely bend the blade very slightly, and will in no way impair its serviceability, whereas the additional loads imposed on a wooden blade will often be such as to break the blade off



A typical De Havilland v.p. airscrew.

AIRSCREW BLADE MATERIALS

Hollow steel should be superior even to dural from the point of view of resistance to abrasion by stones, but may suffer more from damage due to bullets or cannon shells. It has also yet to be shown that the early troubles of fatigue cracking of hollow steel blades, due to panting of the sheeting, have been completely overcome, though there is no doubt that the situation in this respect has improved enormously during the past few years.

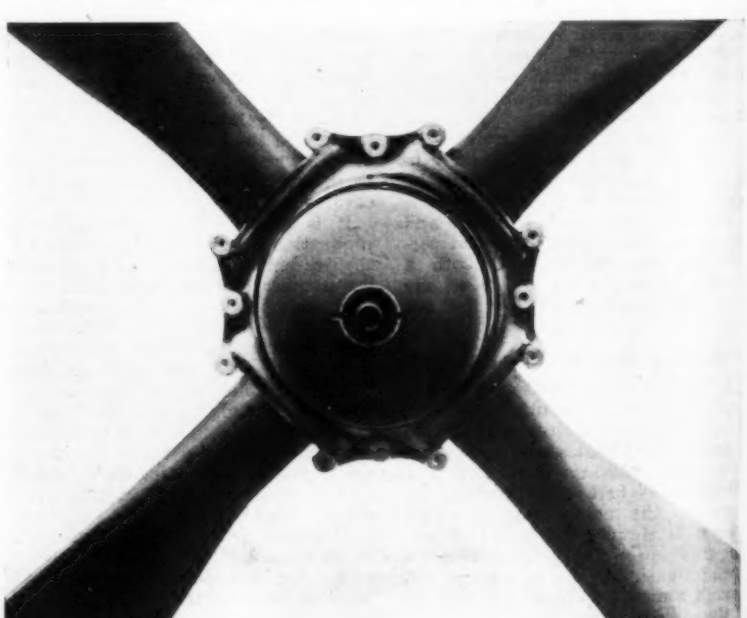
Magnesium requires very careful servicing in order to remove any indentations as soon as they are formed; otherwise, owing to its notch-sensitivity, fatigue cracks are likely to start. It is also extremely subject to corrosion. On most installations, therefore, it cannot be considered particularly good from the point of view of wear and reliability, but on machines where careful attention can be paid to servicing, and vibration stresses in the blades are low, magnesium *can* be used.

Reparability

This is a factor which is often neglected when different materials or designs are being compared, but in wartime it is of paramount importance, and even in peacetime it should by no means be overlooked. Its importance can, perhaps, be judged from the fact that of all the airscrews which are returned to De Havillands for repair, including blades which have been pierced by bullets, and blades and hubs which have been bent or damaged in crashes, over 80 per cent. of the blades and 85 per cent. of the hub parts are repaired and returned to service. Damage marks in the leading edges of dural blades caused by contact with the ground in a crash, or by abrasion from stones on aerodromes, can simply be smoothed out, and even bullet holes can be cleaned up and faired out, and the blades can be returned to service. Blades which have been bent can nearly always be straightened, and, if the bend is not too serious, it is even possible to do this work without re-heat treatment.

Here, again, magnesium compares very unfavourably with dural, as the extent of possible repair is less, and the susceptibility to damage is greater. Wood shows up better in this respect than it did a few years ago; it has now been found possible to repair broken blades by splicing on a new outer portion. It should be remembered, however, that this form of repair will have to be carried out on every blade which is involved in a crash, as the blades will always be broken and not merely bent, as in the case of a dural blade. It therefore means that a complete new outer section of the blade has to be manufactured, and that after attaching to the old root the whole blade must be re-covered.

From the point of view of reparability, hollow steel shows up perhaps worse than any other material because a crash will almost certainly involve buckling of the steel sheeting, and although suggestions have been made from time to time that it might be possible to straighten blades in this condition, it seems unlikely that this will ever be a really practicable job.



The hub and blade roots of the new De Havilland four-blader.

AIRSCREW BLADE MATERIALS

Octopus corner. Most of these damaged De Havilland airscrews can be repaired and put into service again.

It therefore appears that it will be necessary to allow for 100 per cent. scrap on hollow steel blades which are involved in a crash.

Weight

It was on the basis of weight saving that wooden blades were first proposed as an alternative to dural; as a general figure it used to be quoted that a wooden-bladed airscrew would be some 20 per cent. lighter than a corresponding dural one. A few years ago this was, in fact, the situation, but recently progress has been made in the reduction of weight of dural blades. What has made possible this reduction is the introduction of means for measuring the vibration stresses in dural blades while they are actually operating on an engine. When a dural blade fails, the failure can almost invariably be traced to fatigue and not to any effect of steady stress, so that it used to be necessary to design a duralumin blade to withstand the steady stresses imposed on it, and then vibration stresses, which, at that time, were a completely unknown quantity.

For some years past now it has been De Havilland's practice to carry out strain gauge measurements on their airscrews on each new engine application. If the vibration stresses are found to be high, it has often been found possible, with the co-operation of the engine manufacturer, to make changes to the engine which smooth out the most severe vibrations, thus reducing the stress level not only in the airscrew but also within the engine itself. In other cases, where no change in the engine could be made or was desired, a modification could be made to the blade which would alter the r.p.m. at which it resonated with the excitation from the engine, and so ensure that the conditions of high stress occurred outside the running range of r.p.m. In one particular case, high stresses were recorded in the tips of a blade, and a change in the design was made in which the blade was thinned and its weight reduced by some 5 lb., and at the same time the vibration stresses reduced by some 30 per cent.

This is typical of the way in which vibration stress measurements help the designer of a dural blade to reduce weight. Now that these stresses can be measured and, if need be, reduced by a modification to the engine or airscrew, very much thinner blade sections can be used than would have been considered safe a few years ago, and, what is more important from the point of view of weight reduction, the diameter of the shank of the blade can be reduced considerably. The extent of this saving can, perhaps, best be judged by the fact that a blade shank size which was originally designed for an airscrew to absorb 750 h.p. is to-day running most satisfactorily on engines of the 2,000 horse-power class.

No corresponding developments have taken place to reduce the weight of wooden blades, and it is indeed difficult to see where any major reduction can be made. The dimensions of a wooden blade are dictated much less by vibratory stresses, owing to the inherent damping in the material itself, and the sizes are determined by the steady stresses. The only way to reduce the weight of a wooden blade, therefore, seems to be to increase the strength of the material without increasing the density, or to reduce the density without reducing the strength. Since during the past developments in improved wood, weight and strength have always been increased or reduced together, there does not seem to be very much hope of obtaining any startling improvements in this respect.

The indication, therefore, is that, while some further reduction in weight per horse power on dural airscrews is still possible as vibration research proceeds further, it is unlikely that wood will develop any faster and most probably not so fast. To-day the weights of a dural or a wooden-bladed airscrew for the same installation are almost identical. Sometimes wood may be a few per cent. lighter, but in many cases the dural airscrew will actually be lighter than the wooden one.

Magnesium was first introduced because it seemed to offer a weight saving over duralumin, and such a saving was, in fact, obtained. The saving is not quite so great as would at first be thought, because the sections have to be made larger in order to give the greater factor of safety required by the notch-sensitivity of magnesium. It is, however, possible, if the vibration stresses on the installation can be made sufficiently low, to build a magnesium airscrew which shows a weight saving of some 10 to 15 per cent. as compared with dural.

Hollow steel appears also to offer the possibility of a saving in weight over dural, particularly for very large sizes of airscrew. Considerations of the strength and stiffness of the structure in buckling seem, however, to offset the apparent initial advantage, and on typical present-day installations the weights for dural and hollow steel appear to be very similar. It is possible that further development of the hollow steel blade may enable further advantage to be taken of its apparent possibilities in weight saving.

Adaptability

One of the great advantages of a dural over a wooden blade is that it can be made with a relatively small root diameter, thus giving easy adaptability to any type of hub without making the hub of an excessive size. This is of particular importance in multi-bladed airscrews. A four-bladed airscrew of large shank diameter will mean that it is necessary to have quite a large separation between the four blades to avoid interference between the roots, while a small shank diameter, such as is obtainable with the dural blade, enables the roots to be kept close in to the airscrew shaft.

Magnesium again is a little bit worse than dural, though the difference is not very great.

Hollow steel construction, as used in present designs, appears to give root sizes rather similar to dural blades, but here, again, it seems that some

improvement might be possible on future types.

Conclusions

In drawing conclusions from the foregoing arguments it is essential to consider for what type of service the blade under consideration will be used. At the moment, as we are in the midst of a major war, it is natural to consider first what type of blade is best suited to war conditions. Under such conditions, ease of manufacture and reparability should probably be considered of first importance, though efficiency and low weight are also of great importance. It is therefore evident that the solid duralumin blade fulfils these conditions far better than any other type, as it shows up well on all these headings. Hollow steel should be ruled out for its lack of reparability, and magnesium might, perhaps, be used in a few installations, but the necessity for constant attention to avoid fatigue failures makes it unsuitable for general use. Now that dural has wrested from wood its last technical advantage of lower weight, it is difficult to envisage a case for using wooden blades on any but a few special applications where it can give aerodynamic advantages, except for the purpose of utilising existing facilities for the manufacture of wooden blades.

If, however, we review the situation when peace returns, and we have to consider civil aircraft operation, the picture is somewhat changed. Reliability and wear become of primary importance, and the value of reparability becomes less. Ease of manufacture ceases to be of such major importance, though cost must still be considered very seriously. The technical points of weight and aerodynamic efficiency must, of course, still be given their due importance. Under these conditions it is still difficult to see a case for the use of wooden blades, and magnesium is little better. Hollow steel, however, now becomes quite a serious competitor to duralumin, provided it can be definitely established that troubles due to fatigue cracking have been overcome, and it would not be surprising if the return of peace saw the introduction of hollow steel blades for civil use. It is, however, possible that dural may still be able to retain pride of place if it can be made in the form of a hollow blade.

BARRAGE GIRLS

A Visit to a Balloon Training Unit

EVERYBODY has known for some time that members of the Women's Auxiliary Air Force are being trained to take charge of barrage balloons, and, as a matter of fact, one batch has already started work in the Balloon Command, but still it was a very interesting and unique experience to see some hundreds of these girls under training.

The reason for this innovation is that by using women some thousands of able-bodied airmen could be set free for other tasks in the R.A.F. This rather suggests that work in the Balloon Command is a bit of a "cushy job." Such an idea would be quite mistaken. It is an exacting job, though it does not call for the strength of a Hercules. The first general idea was that the women wanted must resemble Tennyson's "eight mighty daughters of the plough," but the C.O. of the station says: "I don't want brawn; I want brains." The girls must be physically fit, of course, and they will get fitter as they go through their training course, but they must certainly be mentally alert. The C.O.'s ideal is an outdoor girl with a mechanical sense; one, for instance, who has been accustomed to a car engine. The Balloon Barrage deals with motor winches as well as with balloons, and the airmen or airwomen have to keep them in running order.

A Very Keen Lot

The first lot of girls to be trained (all volunteers, of course) have shown tremendous keenness, and have, so to speak, lapped up the instruction given them. They come from all sorts of callings, fisher girls, jute workers, actresses and many other walks of life, including one girl who said she had never done any work at all before. An R.A.F. officer instructor said that girls from Scotland were particularly good, though he did not come from North of the Tweed himself. But his main preference was for domestic servants and shopgirls. The former had learnt to work hard and to keep things clean, while the latter had got used to keeping their tempers when dealing with all sorts of unreasonable people. Somewhat sardonically, he remarked that when about sixteen girls had to live together for ever so long on a balloon site the ability to keep one's temper would be a considerable asset.

The Curriculum

The course of training lasts for some weeks, one week being a holiday. The instructors are men, some of them N.C.O.s and some civilian. The course is in two parts, one dealing with the balloon and the other with the winch. For the last two weeks, after the week's holiday, the girls are organised in crews, each under a woman sergeant, and go out into the country near the station and live in tents on a balloon site, keeping a balloon flying all the time.

In the early weeks, called the initial period, they listen to lectures on the parts of a balloon and on the general outline of the scheme. Then they get some hours of instruction (not continuously) in the dope-room, where they are taught to identify the different varieties of fabric, learn herringbone stitching, as the Balloon Command uses it, and use electric sewing machines. Fabric work and stitching must be good, or a balloon will not stand up to a gale, and an instructor officer remarked with emphasis in that room that men are better than women at fabric work. That is not what one would expect, and it probably put that class on its mettle. Privately, he said that women have gentler hands on winch control, and he did not expect that they would snap so many cables. Then there are lecture-rooms for splicing ropes and wire. The girls have to learn a couple of dozen knots, and must be able to make an eye-splice, a short splice and a back splice. Learning all about ropes takes longer than learning to splice the wire. The instructor thought that the girls did not cut their hands so much as the men did, though they splice the wire without gloves. They were not horny-handed girls either; most of their hands were white and well cared for. I only noticed one with red pigment on her nails, and, as she was busy splicing a rope, the colouring matter looked rather the worse for wear.

Instruments for testing the purity of the gas have to be mastered, and there is also practical work on a real balloon, mooring by the tail guy, etc. There was a minimum of drill, smartly performed, and when the A.O.C. Balloon Command came suddenly into a room, the way the girls all sprang to attention was distinctly good.

On the Winch

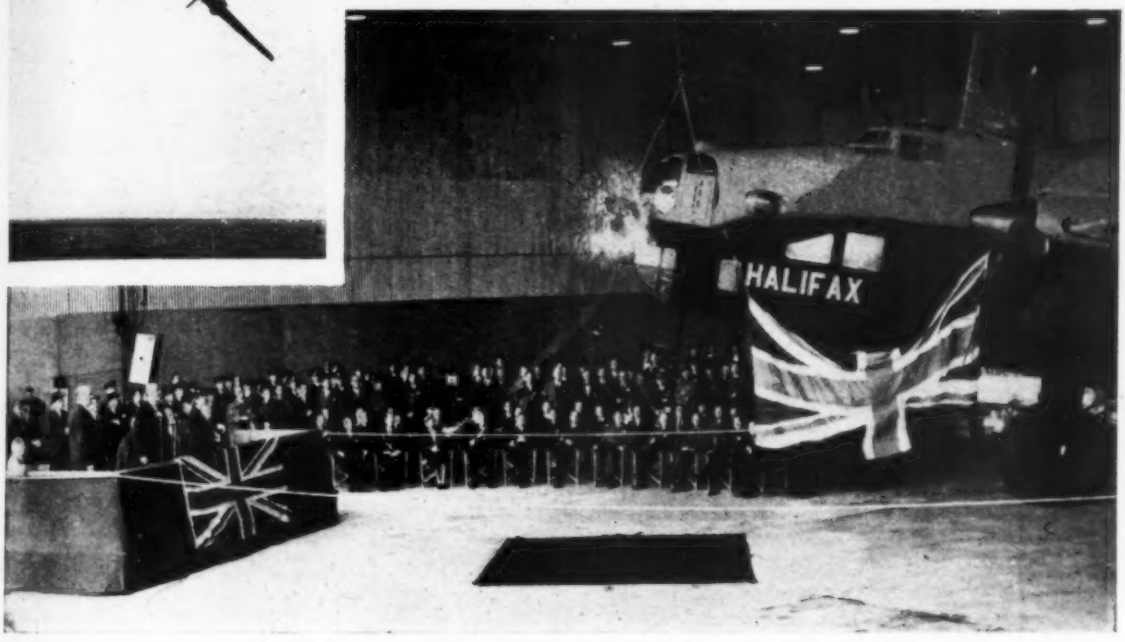
A winch has two engines, one to move it about, the other to wind in the cable. So the girls learn about carburettors and other parts of an engine. To control a balloon from a winch is the summit of the ambition of these girls. Some very competent and confident work was seen on the visit. A balloon is always a tricky thing to handle, and never gives its attendants much time to be bored. Even on winter nights the girls on duty will probably be kept fairly warm by their work.

No praise seems too high for these girls, but it should not be forgotten that all the spadework of the barrage was done by men and, in the first place, by men of the Auxiliary Air Force working in their spare time. They, too, deserve lots of credit. And there are still certain sites where it will be best to keep crews of men.

HALIFAX

First Details of One of Great Britain's New "Heavies": Formidable Offensive and Defensive Armament

(Illustrated by "Flight" Photographs)



An historic occasion: Lady Halifax christens the machine by breaking a bottle of champagne on its nose.

WHEN Lady Halifax christened one of the new Handley Page four-engined bombers last week, she christened not merely one aircraft, but a whole family, for, as the enemy knows from experience, these machines have already wrought havoc on German and Italian targets. As Lord Halifax said in a speech before the christening ceremony, there is an old Yorkshire prayer: "From Hull, Hell and Halifax deliver us," and the time is coming when the enemy may well come to echo the latter part of that sentiment.

It was not until the Halifax was wheeled out of the hangar after the christening that one could form any real opinion of the new bomber. The writer was irresistibly reminded of a day during the last war, when the Handley Page o/400 was similarly wheeled out of its hangar at Hendon and subsequently flown. It is no detriment to the Halifax to say that that first view of the o/400 was more impressive. One had never seen an aeroplane comparable in size, and thus there was an element of awe which, somehow, was absent when the tractor brought the Halifax out on to the aerodrome. And yet the new four-engined bomber is as far ahead of the types to which we have now been accustomed.

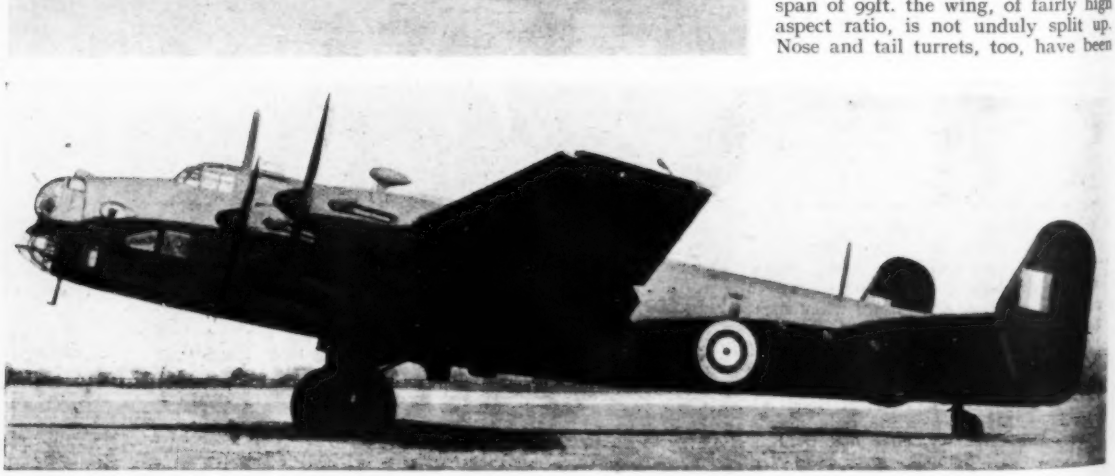
At first one is puzzled by this absence of awe. But as one walks around the machine and inspects it in more detail, one realises that the "ordinariness," if the expression may

After the ceremony: Mr. Handley Page discusses the bomber with Lord Halifax. On the left Lady Halifax is talking to Mr. S. R. Worley, chairman of Handley Page, Ltd., and on the right are seen Mrs. Handley Page and Lord Sempill.

Impressive size: The man under the wing lends scale to the picture above, and other views indicate general features and the manoeuvrability which has been so well combined with size in the Halifax.

be forgiven, is due to the excellent lines and proportions of the aircraft. Not until men are seen near it does one realise the size. We have no idea who laid out the general outline, but whoever it was deserves great credit. The Halifax *looks* right, and, judging by the manner in which Mr. Talbot, the firm's test pilot, "threw it about," it is right. We gather from Mr. Handley Page that the Halifax is one of those rare aeroplanes which were right from the very beginning. When that happens, the result is always very much better than any that can be obtained by modifications of the original design. In the case of the Halifax, the only "mod." of any importance was a slight shifting of the rudder hinges.

Of the performance and bomb load nothing may be said, but when Mr. Talbot flew across the aerodrome at full speed, and only a few feet up, it was not difficult for the experienced to make a very shrewd guess at the top speed. The combination of range and bomb load could not be so easily estimated; but it is good, of that there is no doubt. The cleanness of the aerodynamic design is obvious, and with four Rolls-Royce Merlins on a span of 99ft. the wing, of fairly high aspect ratio, is not unduly split up. Nose and tail turrets, too, have been



HALIFAX

worked into the design in such a way as to interfere but little with the air flow.

On the day of the demonstration, Mr. Talbot did a down-wind take-off. The Handley Page slotted trailing-edge flaps appear to be very effective in giving, at one position, great increase of lift without much increase of drag.

Structurally the Halifax is, needless to say, of all-metal construction. The Handley Page system of breaking down the structure into a number of units has been followed, and the resulting production rate is most gratifying.

Reference has already been made to the good shape of the forward and aft gun turrets. Even the "bay window" for the bomb aimer does not spoil the nose, as may be seen from the photographs. His view is, of course, very good indeed, as it that of the pilot, whose cockpit is ahead of the engines. Owing to the fact that the leading edge is swept back, the outer engines are set back in relation to the inner engines, and so the lateral view extends abaft of the beam.

Nothing may be said of the internal layout of the Halifax, but it has been designed for comfort as well as utility, and a very effective cabin-heating arrangement is incorporated. Access to the tail is particularly easy, owing to the great depth of the fuselage.

Troubles due to ice formation have not been overlooked, and the tail of the Halifax is equipped with a de-icer. The Rotol airscrews have also received attention, but one would have expected to find other parts of the aircraft guarded against this danger.

Altogether the new Handley Page Halifax is a worthy addition to our growing air strength, and the work which the type has already accomplished places it among the most formidable of our new heavy types. The 0/400 came too late to bomb Berlin in the last war. This time neither Berlin nor many other German cities will avoid the destructive powers of its modern counterpart.

The Merlin engines of the Halifax are staggered, the inner engines being forward of the outer. The airscrews are Rotol. Note front gunner's turret, supplemented by the rear turret shown in the view below.

In the three-quarter rear view can be seen the Handley Page slotted flaps, which improve the take-off by giving extra lift with little increase of drag.

THE SPERRY FLIGHTRAY

Co-ordinating the Indications of Navigating Instruments

THE demand for simplification of the flight indications which a pilot receives from his instrument board is increasing. Indicators and control devices, knobs, dials and lights, have become so numerous in the last five years that they completely cover the instrument panel, walls and roof of the cockpit of multi-engine craft and impose an excessive and confusing burden on the eyes and brain of the pilot.

Many efforts have been, and are still being, made to correct this condition by substituting automatic controls for manual wherever possible, the carburettor being a notable example, and by combining the indications of a number of instruments in a single multiple indicator.

It is recognised that, to the maximum extent possible, the pilot must be relieved of the necessity of continuously watching a multiplicity of instruments indicating the functioning of engines, airscrews, fuel supply and other elements of the mechanism so that he can devote his attention to flying. So on large landplanes and flying boats carrying a crew of three or four members the responsibility is divided among them, the pilot watching the flight instruments and maintaining the course, altitude and speed, the engineer devoting his attention to the engine instruments and controls, and a navigator attending the navigational instruments and the radio, unless a radio operator also is carried. For convenience the various instruments and controls are grouped together as well as possible according to such a division of related functions.

Most instruments needed for safe and accurate flying of aircraft having been provided, the Sperry Gyroscope Co. felt some years ago that consideration of the arrangement and simplification of the instrument indications was important, and therefore undertook studies and experimental work to co-ordinate the flight instruments. The object was to provide "a single indicating instrument which will show on its face all necessary flight information in the most easily interpreted manner."

Cathode Ray Tube

An account of this work has been given to the Institute of Aeronautical Sciences by Preston R. Bassett, vice-president and chief engineer, and Joseph Lyman, senior project engineer, of the Sperry Gyroscope Co. Four years of continual experimenting and testing were devoted to the problem, and, although the work is still unfinished, enough has been accomplished to prove that the method of indication has great value for scheduled flying and for instrument landing.

The Sperry instrument has been given the name Flightray, because of employment in it of the cathode ray for giving a combination of visible indications on a single small face.

The photograph shows the face of the instrument, which is a fluorescent screen on which a variety of luminous patterns can be drawn. This is the screen of a cathode-ray tube. For those who are not familiar with the cathode-ray tube it may be said that this piece of apparatus works by the impact of a beam of electrons on to a glass screen covered with a substance which fluoresces (or, more simply, glows with a soft green light) under the influence of the electrons. When undeflected the beam produces a stationary bright spot on the screen, but it may be made to draw any desired pattern, such as straight horizontal or vertical lines or a small circle, by applying an alternating current to either vertical or horizontal deflection plates in correct phase relationship so as to cause the luminous spot to travel in straight lines or to describe a circle.

Electrical Details

The 2,000-volt direct current required by the tube is obtained by driving a small dynamotor from the 12-volt or 24-volt battery of the aircraft and transforming and rectifying the alternating current delivered by the dynamotor to direct current for operation of the cathode-ray tube. The same machine supplies direct current for the amplifiers used. The total power requirements have been reduced progressively from 240 to less than 100 watts.

The Sperry Flightray installed for experimental testing in the instrument panel of a United Air Lines twin-engine Boeing 247 transport used as a flight research laboratory. (How many controls, dials, knobs, levers and lights can you count? We make it 50, and there are more that cannot be seen.)

THE SPERRY FLIGHTRAY

Certain flight instruments on the aeroplane are each provided with a signal pick-up located between two stationary elements so that, when equi-distant between them, no deflection voltage is applied to the cathode-tube beam, but when the instrument deviates from the normal set position a differential alternating voltage is produced and, when rectified and amplified, deflects the spot and makes a pattern on the screen of the tube.

The pick-up used is a simple electro-magnetic type utilising the principle of the miniature Telegon alternating-current selsyn recently developed by the Kollsman Instrument Co., but only the transmitter element is employed for supplying deflection voltages for the Flightray. The necessary direct current is delivered to the commutated vertical or horizontal amplifiers by a balanced diode rectifier. As the pick-up is small, light and exerts negligible coercive force, it is readily applied to existing flight instruments. And, since it operates at low audio frequencies, the leads to the Flightray can be of considerable length, hence the signal instruments may be located anywhere on the aeroplane. By locating them on the flight panel, duplication of flight instrument equipment aboard the craft can be avoided, and as the pick-up does not affect them they then become stand-by instruments. Dials with which they are provided may be set for any desired altitude, direction and speed, and flying then done by observation of the Flightray without reference to the primary instruments or any thought of numerals in feet, degrees or miles per hour.

What the Pilot Sees

Four pattern figures have been adopted for indication on the face of the cathode tube. These are (1) for altitude of the aeroplane, a long horizontal straight line, or artificial horizon, that moves upward in a dive and downward in a climb and tilts at an angle when banking; (2) for direction, a short vertical straight line that moves to right or left of top centre to indicate amount of change of azimuth, or attitude of the vertical axis; (3) for position relative to flight path, a small circle of light movable anywhere on the screen from normal central position, deflected to right or left as the aeroplane flies to one side or the other of a guiding radio beam and up or down as the aircraft departs vertically from the path of an approach glide beam; and (4), for air speed, a short, straight, horizontal line that moves above or below centre as speed is increased or decreased from normal cruising speed.

Intersection of the axis of the vertical line with the horizon line at right angles through the centre of the dial shows that the aeroplane is in straight and level flight, while with the light circle in the centre of the face it is known to be directly on the radio-beam flight path, hence the utility of the instrument for blind flying and instrument landing.

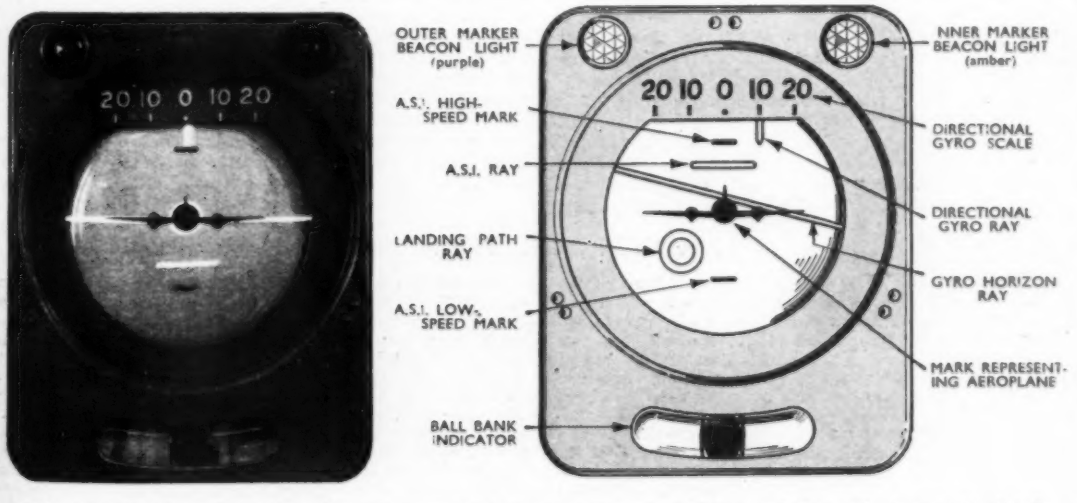
Indicating Direction

Directional indication by the vertical line takes the place of a rate-of-turn indicator, which experienced pilots found they did not need when flying with the earlier experimental instrument. Movement of the vertical line is limited to a segment of 20 deg. to right and left of azimuth, as marked in numerals above the face of the tube. This is done to avoid confusion of the pilot by marking the periphery of the face in 360 deg. and employing a radial line which moves oppositely from the 0 and the 180 deg. marks. This limitation of displacement of the vertical line to a segment of 40 deg. necessitates setting larger changes of course by hand to centralise the azimuth indication, but this has been found to be justified by the avoidance of confusion of indication.

A method of azimuth indication which extensive tests have proved to have particular merit when making an instrument landing is the use of a radio compass for indicating direction. It is planned to make further tests of this, as it is believed to have value as a homing device for route flying as well as for instrument approaches and landings.

A modification of the Flightray recommended by pilots who tested the instrument in hundreds of flights was that attitude and position of the plane be indicated in a pictorial way, as by substituting a miniature silhouette of an aeroplane for the black-painted "bullseye" at the centre of the cathode-tube face, and that this silhouette be "flown" toward any of the luminous indicating patterns to bring the actual aeroplane back to correct heading, position or attitude.

Movement of the circle of light about the face of the instrument has been arranged to be consistent with this idea, so that the miniature aircraft may be directed toward the circle wherever it may be. For example, in cruising



FACE OF THE SPERRY FLIGHTRAY. The gyro horizon ray moves up and down and tilts with changes in attitude of the aeroplane; the short horizontal line moves up and down with changes in air speed. The short vertical line moves right or left with variation from true course. The circle forming a corona around the black centre wanders over the face to indicate position of the aeroplane relative to the flight path. Marker lights are in the upper corners and a ball bank indicator is below the face.

THE SPERRY FLIGHTRAY

flight the circle is deflected up or down by barometric pressure, and therefore indicates departure from level flight; hence, if the circle is above the miniature aeroplane, the control column is pulled back to point the nose up. The horizon line then drops below the image and is held at a definite point until the real aeroplane has climbed again to set altitude, and the circle approaches to enclose the fuselage of the image. Then the control is eased forward until the horizon line rises to bisect the miniature aircraft and the circle.

In landing operations the Flightray is switched so that the localiser beam controls horizontal displacement and the glide-path beam controls vertical displacement of the circle. Then, when approaching for a landing, if the circle should be in the upper right quarter of the dial face, the control column is pulled back, as before, to get altitude, and right rudder is applied simultaneously so that the directional indicating vertical line set to the runway heading will move to the left. It should be held at some arbitrarily chosen position, say, 15 deg., while the circle drifts slowly back toward central position. Just before it rings the miniature fuselage, the artificial horizon and directional gyro lines are brought to normal position intersecting at the centre. It is as if the aeroplane were being flown through a giant tube and were controlled to fly along the true axis indicated by intersecting vertical and horizontal lines, the moving circle of light representing position of the machine with relation to the axis of the tube.

Indication of air speed was deemed of enough importance in instrument landings to be given a place on the Flightray as a protection against approaching a stalling condition. Air speed is, therefore, represented by a short horizontal line which sinks below the centre of the face as speed falls off from normal and rises above centre with increase of speed from normal. A black mark on the screen in the lower quadrant warns that stalling speed is being approached as the air-speed line reaches it.

In the upper right and left corners of the instrument above the tube face are two small lights to give marker information for either route flying or instrument landing, and below the face is a ball bank indicator for showing the correct degree of bank to maintain.

The four separate indications on the screen of the cathode tube make switching necessary. This is accomplished by means of a commutator that applies suitable control voltages successively to the amplifiers connected with the pick-ups of the respective flight instruments. The luminous lines and circle are traced on the screen in sequence at a rate of nearly 60 cycles per second, so they will appear continuous even in a sun-lighted cockpit. Seven distinct types of commutators were investigated exhaustively before one was found to meet the exacting requirements.

Hundreds of flight tests of the Flightray have been made since the spring of 1937, first on the Link Trainer, then at the Indianapolis Airport in the summer of that year and at Newark Airport in 1938, with the co-operation of the Civil Aeronautics Board, United Air Lines, the Bendix Radio Corporation and the Radio Corporation of America. Important contributions to development of the instrument were made by Professors E. L. Bowles and C. S. Draper, of the Massachusetts Institute of Technology, who have been developing a cathode-ray three-point indicator for instrument landings, and F. L. Moseley, who was in charge of the Sperry project during the first two years of its development.

Test pilots commented favourably upon the material aid given in control of the Link Trainer by the combination of readings on a single instrument and the distinctive soft green fluorescence of the patterns on the screen. Numerous suggestions made by airline and military pilots have been incorporated in the instrument.

AFTER THE WAR

(Continued from page 168)

war era is by no means clear to Maj. Robertson—we shall have within our grasp an unequalled method of ensuring that the history of the nineteen-thirties does not repeat itself, provided we have the sense to retain it and the will to use it in the unlikely event of that ever becoming necessary. If we repeat the crass folly of 1919 and disband the Bomber Force, or if we lack the essential guts to use it when the alternative is inevitable world war, as it was when the Boche started rearming under our noses less than 10 years ago, then we are lost and may as well make up our minds forthwith to sink to the level of Rumania.

The Churchill-Roosevelt declaration recognises the vital fact that if civilisation is to survive Germany must not be left in a position, or allowed to regain a position, to "embark on a career of aggression." We cannot keep a great Army of Occupation permanently in Europe, and sea power alone would not prevent German rearmament. The only answer is to use Bomber Command to ensure, by methods on the lines of those first conceived by Lord Trenchard for maintaining order in undeveloped countries, that Germany is never again in a position to terrorise her civilised neighbours into submission. This can be done, without any threat to bomb civilian populations, by the recognised method of preliminary warning. It could not have been done two years ago, because it requires, as a first essential, the moral courage to take responsibility and risk unpopularity that was so rare in a democracy. But can it be doubted that a democracy that has suffered, as we have suffered, at the hands of a "thug with a bomber force" will not hesitate to use its power to prevent a recurrence of the bloody baboonery of 1938 to 1942? Let us hope not. For, if so, no sea supremacy and no Army, however well equipped or rapidly expandable, will prevent another war by 1960. And that will be the end.

CANADIAN AIR TRANSPORT

IN our issue of June 26th we reprinted in full under the title of "Montreal versus London" an article which had been published in *American Aviation* and which contained the statement that the "Canadian Pacific Railroad has purchased or acquired control of eight airline companies," among which were named Canadian Airways, Arrow Airways, Dominion Skyways and Quebec Airways. We have now been asked by Mr. G. W. Hutchins, a director of these companies, to correct this statement by pointing out that the C.P.R. does not own or control them, the control being in the hands of the executors of the estate of the late James A. Richardson.

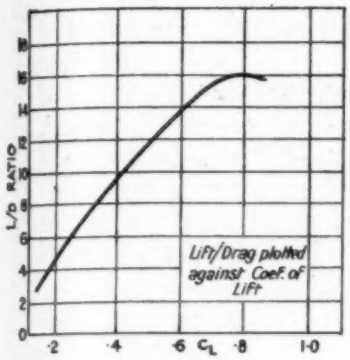
But in the previous issue we had published the statement of Sir Edward Beatty, president of C.P.R., which showed that the railway owned more than $250,000 in Canadian Airways and had acquired a majority interest in Mackenzie Air Service, Yukon Southern Air Transport, Starrat Airways and Transportation, and Ginger Coote Airways. We believe this statement still to be quite correct.

The death of Mr. James A. Richardson in 1939 was the end of the life of one of Canada's airline pioneers. In 1926 he formed Western Canada Airways Limited, and thereby created the first air transport company in Canada to serve the vast mining areas lying to the north of Canada's two principal railways. At first an adventure, this proved an important factor in the rapid development of the northern mining fields. The success of that pioneer company and Mr. Richardson's vision of the future of aviation in Canada were responsible for the formation of Canadian Airways Limited in 1930 to bring together all the important air transport companies operating at that time into one strong company, financed by Canadians. Since its formation, Canadian Airways Limited, under Mr. Richardson's leadership as president, has continued to be one of the leading privately-owned companies operating aircraft in Canada. But plans received an irreparable set-back by the cancellation in 1932 of important Government mail contracts upon which the amalgamation was largely based.

RANGE and FUEL ECONOMY

A Simple Study for Pilots

By "JINAIR"



GREAT strides of progress have been made in teaching our pilots the whys and wherefores of flying for maximum range, but there are still many in the R.A.F. who are not yet conscious of the big difference in the range of a type obtainable by difference of cruising methods. If every R.A.F. pilot made himself an expert in getting efficiency out of his aircraft we would not only save enormous quantities of fuel, but might also save some aircraft.

The problem in its complete form, consisting of a combination of aircraft, engine and airscrew efficiencies, is too extensive to be covered in the space of a short article, but a summary can well be attempted, together with a few hints. In doing so, we will refer particularly to a modern aircraft with constant-speed airscrews.

Optimum Attitude

To put the problem on a very slightly technical basis, it can be expressed thus :—

*Thrust horse power required by the aircraft $\times \frac{1}{\dagger \text{airscrew efficiency}}$

= brake horse power required from engines ;

And B.H.P., $\times$ *specific fuel consumption

= Fuel Consumption per Hour.

From this it can be seen that for maximum range the items marked with an asterisk must be kept low, and that marked with a dagger must be high. To reduce the thrust horse power required to its lowest figure is achieved simply by flying at that speed which, for the particular all-up weight, gives the attitude (angle of incidence) of greatest overall efficiency. This overall efficiency is expressed as overall lift-drag ratio plotted against either the coefficient of lift or the angle of incidence of the wing or of the fuselage datum. Another way of achieving the optimum attitude of flight is simply to use the fore-and aft clinometer. It must of course, be checked for installation to see that it agrees with the fuselage or hull datum. It is up to the engineer officers to see that pilots are provided with information on maximum economy speeds for various all-up weights, and also on the optimum attitude of the aircraft as per clinometer.

For those pilots who like a little arithmetic, the formula for maximum-economy speed is simply :—

$$V = \sqrt{\frac{W}{.5\rho\sigma C_{L_m} S}}$$

where V = true air speed in feet per second.

(Note : indicated air speed is found by omitting σ).

W = weight in lb.
ρ = density = .002378 slugs
σ = relative density
C_{L_m} = Coef. of lift at maximum value of L/D ratio.
S = wing area

From this it can be seen that as the weight decreases, speed must be decreased.

In actual practice it is advisable to fly at a speed a few knots faster than the figure obtained by this means, to be on the safe side.

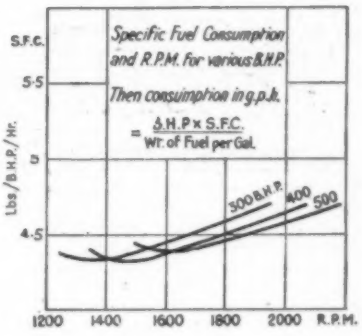
Specific Consumption

The second vital factor in the range problem is specific fuel consumption ; that is, the quantity of fuel burned per horse power per hour. The quantity is expressed in lb. or in pints. The latter method is based on the argument than an aircraft's tanks contain a certain volume, not weight, of fuel. This very practical reason would be excellent were it not for the fact that the weight of fuels in various parts of the world vary very considerably.

However, to keep to the point. The energy which is lost in the internal combustion engine is dissipated by the following :—

(i) Frictional losses
(ii) Power required to drive supercharger
(iii) Pumping losses
(iv) Heat loss to coolant (air or liquid)
(v) Heat losses in exhaust gases.

Now it can be seen clearly that the faster an engine turns, the greater will be the frictional losses. Similarly, high engine speeds mean high blower rotor speeds, with consequently higher power required to turn it. From these two points it can be seen that lower r.p.m. tend to give greater fuel economy. Further, it should be pointed out that at small throttle openings the constriction so caused tends to add to pumping losses. Hence larger throttle openings give improved efficiency.



But—danger :—Great care must be taken to avoid detonation. With low r.p.m. and large throttle openings for a given power there is great danger from detonation. If this does occur, a rise in cylinder head temperature will show it, but considerable damage to the engine may be caused before it is detected. The best method of avoiding detonation is to run at a B.M.E.P. lower than a certain fixed limit. (B.M.E.P. is brake mean effective pressure.) This limit varies with compression ratio, fuel used, mixture, etc. The limiting B.M.E.P should be ascertained from the makers for each type of engine used. To find the B.M.E.P. at any particular set of engine conditions, take the b.h.p off the maker's chart and use the formula :

$$\text{B.M.E.P.} = \frac{\text{b.h.p.} \times 1{,}008{,}000}{s \times b^2 \times \text{r.p.m.} \times \text{cyls}}$$

where s = Stroke in inches
b = Bore in inches
Cyls. = Number of cylinders.

A series of graphs of boost v. r.p.m. for various B.M.E.P , or, alternatively, b.h.p. v. r.p.m., should then be drawn, with the limits for rich mixture and for weak mixture marked. This will then serve as a limiting guide to prevent the possibility of running into detonation.

Airscrew Efficiency

Now, if the two factors, aircraft efficiency and engine efficiency, were the only ones, the maximum range problem would be fairly simple. But interposed is the third factor : airscrew efficiency. To keep the discussion on a simple basis, it is sufficient to say that on most modern aircraft the airscrew efficiency will be reasonably near its peak if the requirements of optimum aircraft attitude and optimum engine operation are complied with for the heavier two-thirds of the weight range. Below this weight, if speed were further reduced in order to maintain maximum aircraft efficiency, the abnormally low engine powers would cause higher

(Concluded at foot of page 181)

HERE AND THERE

He'll Sharpen Things Up!

MR. E. H. COOPER, chairman of Gillette Industries, Ltd., has been appointed war production adviser to the Ministry of Commerce, Government of Northern Ireland. As the Ministry has taken over full responsibility for war production in Northern Ireland, he should be just the man to put a keen edge on the job!

To Encourage Apprentices

A SCHEME which gives the young apprentice added incentive is being successfully operated by Rolls-Royce, Ltd. It consists, very simply, of awarding certificates of merit to all those who complete their period of training in the workshops in a satisfactory manner.

Needless to say, a firm of such high standing does not award these certificates lightly, for it is well aware that they will carry no little weight with those whom their holders may subsequently approach for employment.

Only those apprentices whose reports on their ability, diligence, punctuality and general conduct in the factory reach a certain standard—a high standard, too—can hope to gain a Rolls-Royce Certificate of Merit, and one of the conditions is that they must have completed at least five years with the company. Actual attendance at a technical college is not insisted upon, but it goes without saying that a good technical report, in addition to sound practical work, is an invaluable asset.

The certificates, which state the period served and the departments passed through, are signed by the director and works manager and by the apprentice supervisor.

H.R.H. the Duke of Kent addressed the 13,000 employees of the Glenn L. Martin aircraft plant in Baltimore on August 26, expressing the appreciation of the British people and Government for "every hour put in."

Stop Me and Buy One

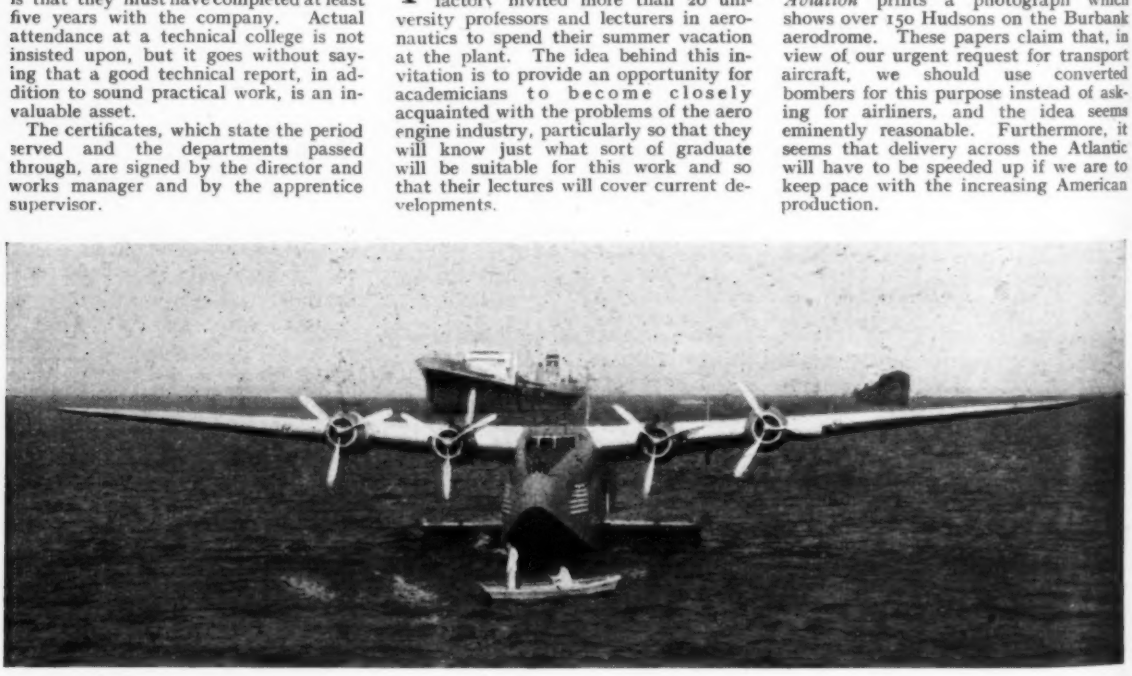
THE Vought-Sikorsky factory employs an expert in eye protection and every day he tours the factory wheeling his "goggle truck" before him, ready to clean, repair or replace any goggles in need of attention.

Academy Visits Industry

THE Pratt and Whitney aero engine factory invited more than 20 university professors and lecturers in aeronautics to spend their summer vacation at the plant. The idea behind this invitation is to provide an opportunity for academicians to become closely acquainted with the problems of the aero engine industry, particularly so that they will know just what sort of graduate will be suitable for this work and so that their lectures will cover current developments.

Delay in Delivery?

BOMBERS for Britain are stacking up on American aerodromes, according to statements of two leading American aviation papers. *Aero Digest*, in a plea that Americans should fly them over the Atlantic, says that it counted 50 Lockheed Hudsons at Burbank, California, and knows of more than 150 at various places on the Atlantic coast. *American Aviation* prints a photograph which shows over 150 Hudsons on the Burbank aerodrome. These papers claim that, in view of our urgent request for transport aircraft, we should use converted bombers for this purpose instead of asking for airliners, and the idea seems eminently reasonable. Furthermore, it seems that delivery across the Atlantic will have to be speeded up if we are to keep pace with the increasing American production.



Two Japanese tankers, the Otowasan Maru and the Nitiei Maru, are shown anchored at San Pedro, California, awaiting a decision as to whether they can or cannot depart with diesel oil for Japan. The Pan American *California Clipper* reminds us of flying as we like to remember it.

Cut from the Nazi film, "War in the East," this photograph shows a Soviet aerodrome on which the aircraft were subsequently destroyed by tracers from the shellguns of the aeroplane which took the film. The film is said to have been captured at sea and is being shown in the newsreels.

Death of R. J. Parrott

WITH the passing of Mr. R. J. Parrott last week British aviation has lost not only one of its pioneers, but also one of its most charming and well-liked personalities. Mr. Parrott was associated with A. V. Roe, now Sir Alliott Verdon-Roe, in the earliest days of flying, and remained with him until that company joined the Siddeley group, later to become the Hawker-Siddeley of to-day. Still more recently Mr. Parrott became commercial manager of Phillips and Powis, Ltd. Among his many activities were those of works manager and foreign representative. He travelled much for his firms, so that he made friends all over the world. His death is a sad blow to all who had the good fortune to know him.

Engine Load Recorder

FLUGWEHR UND TECHNIK has a description of the Peravia engine load recorder which is not only an engine revolution counter, but also takes account of the induction manifold pressure. Engine overhaul periods are specified in hours of operation, irrespective of whether the operation is at high power or low, a factor which has a great effect on the condition of the engine. The Peravia instrument is not fully described, but it is probably connected to the engine by gearing whose ratio is affected by the manifold pressure. By means of it engine overhaul periods can be specified in terms of the figure on the dial of the recorder instead of in hours.

American Radiolocator

AN American patent which reveals some details of a radiolocating device has been described by *Interavia*. Waves are transmitted outwards and reflected back from the object to be detected as in the absolute altimeter developed by the Western Electric Corporation. But, whereas the altimeter transmits its waves in all directions, the radiolocator sends out a beam focused by a parabolic reflector. When reflected back the direction and distance of the aircraft can be determined, the latter by means of the elapsed time required for the signal to return. By to and fro movements of the beam a certain area of sky can be continually surveyed. Whether such a locator is in use yet is not known. The wavelength is 50 cms.

German Parachutes

THE manufacture of German parachutes is described in a recent number of *Luftwissen*. More than 40 sq. yds. of silk are required for the canopy, which consists of 96 parts. Cutting out is done by electrical machines which deal with several hundred parts of the same shape at once. Sewing is done on special four-needle sewing machines and the seam afterwards examined for faults by means of transmitted light. Opening even at speeds of 370 m.p.h. can be accomplished, which must throw considerable strain on the parachute. Landing speed is said to be 23ft. per sec., though those for supplies descend faster.

Mapping from Air Survey

THAT the smallest and largest scale maps are not best prepared by aerial survey was the opinion expressed recently by A. T. Britton, of the Main Roads Department of New South Wales. But the middle scales, between one mile to the inch and one-tenth mile to the inch, are specially suited to aerial survey and should almost always be prepared in this manner, he considers. Maps of this class are used for the design of all important engineering works. Flying and photography for a scale of one-quarter mile to the inch will cost about 25s. per square mile, but may be as low as 15s. Other costs are: Ground control, 10s.; printing and reproduction, 5s.; plotting, £2; making a total cost per square mile of £3 10s.

Broad Tips

LATEST patterns of Hamilton Standard airscrews now being produced are very much broader at the tips than former designs, the blade being almost the shape of a canoe paddle. Whether this is indicative of any fundamental changes in airscrew design is not yet apparent, but it is known that airscrew research dealing with laminar flow has been in hand in the N.A.C.A. for some years past.

De-icer Improvement

THE B. F. Goodrich Company has a patent on an improvement of their well-known pulsating rubber shoe wing de-icer. The rubber shoe is attached to the wing by means of a metal strip running lengthwise along the wing and it was found that ice deposited on this could not be removed. The improvement consists of a secondary layer of soft rubber which covers the metal and is stretched by the pulsations of the rubber shoe, so preventing the adherence of ice on the metal strip.

Douglas Perspective

THE use of perspective drawings, similar to the type made by *Flight* artists for illustrating our own articles, is a new development in aircraft factories, but the Douglas Aircraft Company has such a department with over twenty artist-engineers in it. It has been in existence for two years and is in charge of George Tharratt, who used perspective diagrams when a Royal Air Force technical officer in the last war. The blue print giving plan and elevation drawing will never be superseded, but the reading of the present-day drawings with their wealth of detail can be much facilitated with the help of perspective cut-away three-dimensional drawings. They are particularly useful in any assembly operation. Photographs of assemblies with each component part numbered are also used for this purpose.

RANGE and FUEL ECONOMY

(Continued from page 179)

specific fuel consumption, and the low r.p.m. would possibly cause a sudden drop in airscrew efficiency.

As a rough guide, therefore, it can be said that for maximum miles per gallon, and hence maximum range, it is generally best to fly at the attitude of maximum L/D ratio, reducing indicated speed in proportion to the square root of the weight, using fairly low r.p.m. for the first two-thirds of the consumable load, after which indicated air speed might well be kept constant.

In reading this, there will be many Service pilots who will argue that they cannot be expected to adopt such a fussy procedure and such low speeds on operational flights. This is quite correct. But to *know* how to obtain maximum range when occasion demands is a simple piece of background knowledge which every pilot should possess.

[There is an obvious error in the right-hand graph at the head of the article. The figures 4.5, 5 and 5.5 should read .45, .5 and .55.—ED.]

Correspondence

The Editor does not hold himself responsible for the views expressed by correspondents. The names and addresses of the writers, not necessarily for publication, must in all cases accompany letters

SUPER-SPIN

Canadian "Record" Claim Challenged

I WAS interested to read in your last week's issue that a Canadian pilot claimed as a world's record a spin from 11,500ft. to 2,300ft.

I am sure many of your readers can claim better performmances than that. I myself have been in a longer spin, though I make no record-breaking claims for it.

In 1934 I went up in a friend's aeroplane over Cairo. The machine was a Percival Gull, newly acquired, and was reputed to be difficult to control in a spin. The object of our flight was to find out if this was so, and at the same time to find out the aeroplane's ceiling. The ceiling proved to be 13,500ft., and we started our spin there. Owing to the weight in the back seat, the spin became very flat, and nothing the pilot could do would bring the controls into action. Eventually he held the stick right forward and waited for results.

We came out of the spin at just over 2,000ft. We were too interested in the final result of the experiment to count the number of turns or the duration of the drop. We must have fallen much faster than the Piper Cub, and, therefore, probably did less turns.

I can confirm the fact that after a time we ceased to notice the turning effect. During the spin we were able to discuss the problem, and see quite clearly what part of Cairo we would demolish if we continued on our course.

PATRICK LORT-PHILLIPS.

ASKING FOR TROUBLE

Flying to the Danger of the Public?

AT a time when the R.A.F. is doing such magnificent work in the defence of this country and all free peoples, one hesitates before voicing anything in the nature of a complaint against any section of this gallant Service. This letter, therefore, is written more in the spirit of enquiry than of criticism; I want to know if it is really necessary, in learning to defend the many, to imperil the lives and limbs of even a few of our own people?

A short time ago there was a regrettable accident at Blackpool when two R.A.F machines, flying low over the town in a formation, collided and crashed with the loss of some 14 or 15 lives; one crashed through the roof of the Central station into the booking hall crowded with people, and the other fell on a house not far away.

One would have thought that, after such a dreadful calamity the R.A.F. authorities in that area would have taken a very firm attitude against any *unnecessary* low flying over such a thickly populated district, but while on a visit there a few days ago I saw things which made me seriously doubt if a strict enough hand is being kept upon young pilots who, with a quite natural enthusiasm and a spirit of dare-devilry which makes them the world's best air fighters, are apt to take risks, not essential to their training, that endanger those on the ground too.

I take off my hat in grateful admiration of the stout young hearts, cool heads, and skilful hands and feet that keep the Focke-Wulf from the shore. I know that you cannot put old heads on young shoulders, and I also understand and applaud the admirable dash of these splendid youngsters, be they Britons, Poles, Czechs, Norwegians or Free French—we all know where we should be without them—but there are older heads on older and more experienced shoulders whose job it is, I suggest, to see that this splendid spirit is properly disciplined and not allowed, in its forgivable enthusiasm, to imperil the very lives it is entrusted with protecting.

Yet I saw several instances of dangerous low flying which appeared to me to be quite unnecessary. Three examples will suffice, viz., a "Maggie" skimming along above the heads of people on the promenade, *below* the level of the cliff top and not many feet away from it. I was riding in a tramcar and saw just the heads of its two occupants until, farther on, the complete machine zoomed up into view to clear the North Pier. Three Spitfires in formation flying not more than 30ft. above the edge of the water, over a beach dotted with bathers, paddling children, and other people. A Hurricane which dived down towards the populated beach from several hundred feet and only pulled out of its dive some 50ft. from the sands.

Maybe the Hurricane pilot was practising diving at a ground target, but could he not have found a deserted spot, such as an empty field? Perhaps the three Spitfires were being exercised in the very necessary art of high-speed "evasive action," but surely they could have done it well out over the water, clear of paddling children? Frankly I can think of no excuse for the cliff-skimming "Maggie," but if this manœuvre had some useful purpose it could hardly have been executed in a less suitable place.

While in Blackpool I learnt that the R.A.F. there has earned a reputation for constant low flying over the town and the seafront, and the observation of the average resident is: "It's a wonder there aren't more accidents, but I suppose it's necessary and can't be helped."

From what I saw I suspect that much of it is *not* necessary and that it *could* be helped; significantly enough there are scores of R.A.F. training centres in other parts of the country where this sort of thing definitely does not happen.

Or am I just another of the "wrong-headed mischief makers" whom Sir Archibald Sinclair so dislikes?

"BLACKPUDLIAN."

Can This Be True?

THE American monthly, *Aero Digest*, carries the following story in its July issue:

"Plans for an organisation to canvass the country for applicants to train for flight jobs in transatlantic ferry service were announced last month by W. G. Golien, who has been detached from his regular duties as one of T.W.A.'s chief pilots for this purpose. The organisation will interview and accept for training prospective pilots, co-pilots and navigators for the Atfero service of Montreal.

"According to Golien, pilots accepted for duty in the ferry service will receive $1,500 per month salary. Co-pilots will receive $1,200 and navigators $900. In addition to salary, pilots will receive a bonus of $2,500 for each 10 round trips and an extra bonus of $5,000 at the end of 25 round trips. Bonuses of $2,000 and $1,200 will be paid to co-pilots and navigators for each 10 trips, and an extra bonus of $4,000 and $2,400 respectively after 25 round trips."

Calculating the total annual payments on the conservative assumption that a crew delivers 25 aircraft per year, these come out at $29,250 (£7,250) for a pilot, $23,400 (£5,800) for a co-pilot, and $16,200 (£4,020) for a navigator.

Lockheeds in Australia

THE Australian firm of W. R. Carpenter Airlines, which runs from Sydney north along the coast of New South Wales and Queensland, then across Torres Strait to New Guinea, has added two Lockheed 14H airliners to its fleet. These replace two DH 86Bs which the firm previously relinquished to the Commonwealth of Australia for use by the R.A.A.F.

A.A. and Altitude

IN an article in *La Science et la Vie*, A. Fournier writes that aircraft operating at an altitude of 20,000ft. are practically immune to A.A. fire of the heaviest calibre (3.5 to 3.7in.) and that even if the calibre is increased to about 6in. the aircraft can be practically safe if they ascend to an altitude of about 26,000ft. These figures apply to daytime, when the predictor gear can be operated visually and therefore with the greatest effectiveness.

He also expresses the opinion that, at night time, A.A. fire at these altitudes is simply a waste of ammunition, but admits that A.A. batteries serve a useful purpose by preventing a descent into lower altitudes.

Service Aviation

Royal Air Force and Fleet Air Arm News and Announcements

Air Ministry,
September 9th, 1941.

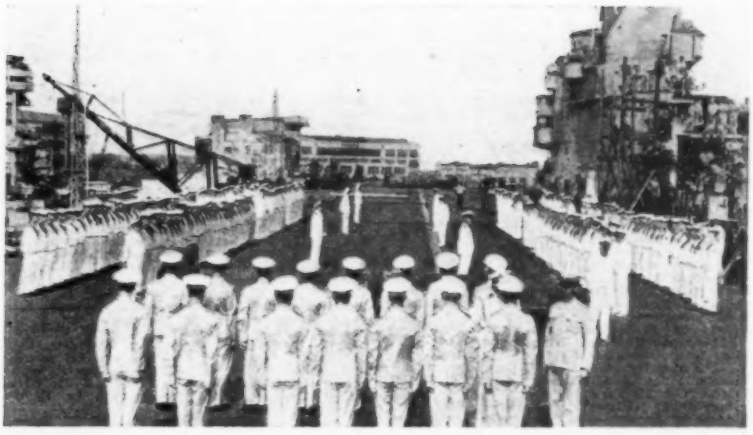
THE KING has been graciously pleased to approve the following awards in recognition of gallantry displayed in flying operations against the enemy:—

BAR TO THE DISTINGUISHED FLYING CROSS

Wing Cdr. John Woodburn GILLAN, D.F.C., A.F.C. (missing).—This officer has led the wing on nineteen occasions since July, 1941, and his fine leadership and cool courage have been an inspiration to his fellow pilots throughout all operations. On three recent escort missions Wing Cdr. Gillan has displayed especial skill and determination. He has destroyed one and damaged another enemy aircraft.

Act. Wing Cdr. Douglas Robert Stewart BADER, D.S.O., D.F.C.—This fearless pilot has recently added a further four enemy aircraft to his previous successes; in addition he has probably destroyed another four and damaged five hostile aircraft. By his fine leadership and high courage Wing Cdr. Bader has inspired the wing on every occasion.

Act. Sqn. Ldr. Peter William Ober MOULD, D.F.C., No. 185 Squadron.—This officer has led the squadron on 62 daylight sorties since May, 1941; in addition, he has carried out 7 night sorties. Under his leadership the unit has destroyed eight, probably destroyed fourteen and damaged seven hostile aircraft; Sqn. Ldr. Mould has destroyed one and damaged two. By his magnificent example and courage, Sqn. Ldr. Mould has contributed largely to the high standard of operational efficiency and morale of the squadron.



ILLUSTRIOUS COMMAND. Lord Louis Mountbatten, the King's cousin, is taking over command of the aircraft carrier *Illustrious* which was recently overhauled in an American shipyard. In this picture the new commander is inspecting his crew.

Act. Flt. Lt. Brendan FINUCANE, D.F.C., No 452 (R.A.A.F.) Squadron.—This officer has led his flight with great dash, determination and courage in the face of the enemy. Since July, 1941, he has destroyed three enemy aircraft and assisted in the destruction of a further two. Flt. Lt. Finucane has been largely responsible for the fine fighting spirit of the unit.

F/O. Adrian WARBURTON, D.F.C., No. 69 Squadron.—This officer is a most determined and skilful pilot and has carried out 125 operational missions. F/O. Warburton has never failed to complete the missions he has undertaken and, in the actions fought, he has destroyed at least three hostile aircraft in combat and another three on the ground.

DISTINGUISHED FLYING CROSS.

Act. Flt. Lt. William Pelham HOPKIN, No. 602 Squadron.—Flt. Lt. Hopkin has constantly been in action since July, 1940, and has at all times shown great keenness and determination to engage the enemy. During recent operations, he has proved a capable flight leader and has destroyed at least five enemy aircraft.

Act. Flt. Lt. Eric RICHARDSON, No. 258 Squadron.—This officer has been engaged in operations against the enemy for over a year and has destroyed two and damaged two hostile aircraft. He participated in evacuation patrols in France in June, 1940, and, later on, fought in the battle of Britain. Since February, 1941, Flt. Lt. Richardson has taken part in eleven bomber escorts and four Channel sweeps. He has displayed devotion to duty and has set an excellent example throughout.

F/O. Roger Rennels DREW, No. 69 Squadron.—In July, 1941, this officer carried out an attack on the aerodrome at Zuara. Aircraft on the ground were machine gunned, one being destroyed and others damaged. F/O. Drew has also been responsible for the destruction of three Italian flying boats. He has completed 120 operational flights, including a number of reconnaissances, and, throughout he has displayed skill and enthusiasm.

P/O. Jack BUCKLEY, R.A.F.V.R., No. 105 Squadron.—In August, 1941, this officer attacked a 9,000-ton merchant ship off Lampedusa. Destroyers, torpedo boats and a large number of lighters were removing a cargo of motor transport at the time, but P/O. Buckley attacked through a curtain of fire and, although wounded during the run-in, scored hits setting the ship on fire.

BAD-WEATHER BEAUFORTS. The Beaufort crews of Coastal Command have earned a name for successful operations against enemy shipping in all weathers and a flight is here seen returning after one more offensive excursion

SERVICE AVIATION

Subsequent reconnaissance revealed that a 700-ton sloop was also sunk as a result of the attack.

Roll of Honour

Air Ministry Casualty Communique No. 79.

THE Air Ministry regrets to announce the following casualties on various dates. The next of kin have been informed.

KILLED IN ACTION (WHILE FLYING ON OPERATIONS AGAINST THE ENEMY).—Flt. Sgt. F. C. Adams; P/O. P. J. N. Adshead; Sgt. W. S. Brooks; Flt. Sgt. A. E. Cave; Flt. Sgt. R. R. B. Durtnall, D.F.M.; Sgt. K. M. Fillmore; Sgt. J. A. Haswell; Sgt. T. S. Hathaway; Sgt. R. D. Hesketh; Sgt. D. A. Monk; Sgt. P. H. C. Parrott; Flt. Sgt. L. Saunders; Sgt. V. R. Sutton; Flt. Sgt. H. A. V. Vidler; Sgt. F. K. Webber.

PREVIOUSLY REPORTED KILLED ON ACTIVE SERVICE, NOW REPORTED KILLED IN ACTION.—Sgt. G. E. Blake; Sgt. W. R. L. Collyer; Sgt. T. A. Grosvenor; Sgt. J. E. Jackson; Sgt. J. F. Markham; Sgt. J. M. Taylor.

PREVIOUSLY REPORTED MISSING, BELIEVED KILLED IN ACTION, NOW PRESUMED KILLED IN ACTION.—Sgt. G. W. Rogers.

PREVIOUSLY REPORTED MISSING, NOW PRESUMED KILLED IN ACTION.—Sgt. A. W. Astle; Sgt. L. P. Brookman; Sgt. S. H. Burley; Sgt. R. Chantry; Sgt. J. H. Davies; Sgt. E. N. Kelsey; P/O. J. B. Latta, D.F.C.; P/O. G. K. Noble; Sgt. L. D. Norman; Sgt. A. H. Paine; Sgt. E. D. Polkinghorne; Sgt. J. E. Rowlett; Sgt. G. C. Sandland; F/O. H. B. Skyrme; Sgt. C. A. Smith; P/O. N. A. Svenson; Sgt. V. Tarrant; Sgt. G. Taylor; Sgt. J. I. Wilson.

PREVIOUSLY REPORTED MISSING, NOW REPORTED KILLED IN ACTION.—Sgt. H. P. Clarkson; Sgt. R. A. Gilbert; Sgt. G. G. Hutson; P/O. P. E. M. Robinson.

WOUNDED OR INJURED IN ACTION.—Grp. Capt. H. Broadhurst, D.F.C., A.F.C.; P/O. D. J. Browne; Sgt. P. Cowen; P/O. H. R. Crombie; Sgt. E. Elliot; Sgt. G. A. Mason; Flt. Sgt. J. F. L. Morton; Sgt. D. Rowley-Blake; Sgt. W. A. M. Savill; Sgt. A. W. Summers.

DIED OF WOUNDS OR INJURIES RECEIVED IN ACTION.—Act. F/O. R. J. Fraas; P/O. H. B. Milman.

MISSING, BELIEVED KILLED IN ACTION.—Sgt. A. J. Appleby; Sgt. G. J. Bishop; Act. Wing Cdr. A. F. C. Booth; P/O. J. R. Bushell; Sgt. K. P. Campbell; Sgt. J. V. Clegg; Sgt. R. V. Collinge; Sgt. N. C. Cook; F/O. C. Cookson; Flt. Sgt. W. H. Dulwich; Sgt. P. H. Eve; Sgt. F. Fullard; Sgt. G. Furney; Sgt. C. G. Goodfellow; Sgt. A. Gordon; F/O. A. T. Grieve; Sgt. F. Griffin; Sgt. L. J. Harrison; Sgt. B. Hassall; P/O. A. Hipps; L.A/C. R. C. Hoddell; Sgt. C. Humber; Sgt. D. H. Jeeves; Sgt. B. F. T. Johnson; Sgt. R. J. L. Larwood; Sgt. G. Lightley; Sgt. D. J. Lowe; Sgt. B. D. Lyon; Sgt. W. T. McDonald; Sgt. P. J. Magee; Sgt. D. J. Mennie; Sgt. L. O. Orchard; Sgt. R. Palmer; Act. Flt. Lt. M. E. Potter; Sgt. B. E. Sale; A/C.2 J. A. Skinner; Sgt. S. N. Symondson; P/O. A. W. Wilkinson; Sgt. C. Wilkinson; Sgt. C. M. Williamson; Sgt. J. C. Wimhurst; Flt. Sgt. D. W. Wyatt; Flt. Lt. E. W. Young.

MISSING.—Sgt. K. C. Amy; Sgt. C. D. Asher; Cpl. E. Astley; A/C.2 J. R. Avery; Cpl. W. G. Aveson; Sqn. Ldr. A. G. G. Baird; L.A/C. A. J. Ballinger; Act. Flt. Lt. R. B. Barr; Sgt. H. T. Barrett; Sgt. H. R. Barton; Sgt. R. A. Bates; A/C.2 W. H. Beament; P/O. J. Bell; P/O. G. N. Bevan; Sgt. D. B. Beverley; A/C.2 T. B. Black; Sgt. K. W. Bramble; P/O. J. P. N. Britton; P/O. J. C. Broadhurst; L.A/C. J. Brown; A/C.2 R. O. Brown; A/C.1 A. R. Bullock; Sgt. T. O. Burgess, D.F.M.; Sgt. J. Campbell; A/C.2 P. H. F. Cane; Sgt. W. D. Capewell; Sgt. R. P. Carling; Sgt. W. E. Chappell; A/C.1 A. M. Cheesman; Sgt. R. B. Chrisp; Sgt. G. Christie; A/C.2 L. W. Claydon; Sgt. W. Cockburn; A/C.1 M. Collingwood; P/O. E. R. F. S. Cooper; A/C.2 P. A. Costello; L.A/C. M. F. Cragge; Sgt. R. S. C. Craig; Sgt. J. M. R. Cruickshank; Cpl. W. G. Cudworth; P/O. B. C. Curtis; P/O. H. J. Daniels; Sgt. W. R. Davey; A/C.2 R. E. Davies; Sgt. V. A. Davis; A/C.1 H. J. Deakin; Sgt. W. M. Deakin; A/C.2 R. Dearnley; L.A/C. R. S. Deighton; Cpl. W. P. Denson; Sgt. A. W. Earp; Sgt. J. S. C. Edge; Sgt. P. J. W. Ennis; Sgt. J. A. Fawkes; Sgt. A. W. Felton; Sgt. R. F. S. Ford-Hutchinson; Sgt. J. A. G. Forsyth; A/C.1 J. C. Forsyth; A/C.1 A. T. Foster; A/C.2 J. E. French; Sgt. G. T. Friend; A/C.1 R. S. Fry; Sgt. P. C. Gammon; Sgt. P. T. Giblett; Sgt. F. Gilby; A/C.2 R. Gilholm; A/C.1 R. H. Girvan; Sgt. R. K. Godfrey; L.A/C. L. E. Grant; P/O. E. S. Hale; A/C.1 J. W. Hall; Sgt. J. W. Hamborough; A/C.1 C. Hams; Sgt. F. J. Hardiman; Sgt. G. Harvey; L.A/C. W. T. Hayward; Sgt. M. Heald; Flt. Sgt. A. J. Heller, D.F.M.; A/C.1 J. Herk; Sgt. W. G. Herrod; Sgt. T. I. Hicks; A/C.1 G. N. Higham; Sgt. A. F. Hill; Sgt. L. Hill; Sgt. R. W. J. Hill; L.A/C. C. Hobbs; Sgt. A. R. Holmes; L.A/C. S. G. Iles; L.A/C. H. Jacques; Sgt. C. F. Jenkins; Flt. Sgt. R. R. Jewett; Act. Flt. Lt. T. F. Kerr; Sgt. F. G. King; L.A/C. J. H. Kirkham; P/O. L. P. Klitz; Act. Sqn. Ldr. P. W. F. Landale; Sgt. C. W. F. D. E. Lawson; L.A/C. S. Leachman; Sgt. G. G. Lee; A/C.1 A. E. Littlejohn; Sgt. H. L. Lotherington; Flt. Sgt. S. J. Lytle; A/C.2 J. McAllister; Sgt. W. A. McGinley; P/O. J. F. P. J. McKenna; Sgt. H. D. MacKenzie; P/O. A. C. Macpherson; A/C.1 B. Malone; Sgt. E. G. Martin; A/C.2 A. Mathie; Sgt. R. M. Milligan; A/C.2 N. E. Mills; Sgt. A. G. L. Mitchell; Sgt. A. J. Mitchell; Sgt. F. L. Molteni; A/C.2 R. D. Moore; A/C.1 V. Morris; Sqn. Ldr. O. R. C. Moseley; Sgt. A. C. Moss; Cpl. A. D. Mowatt; Cpl. S. W. S. Muir; A/C.2 A. D. Munslow; A/C.1 M. Murray; Sgt. L. Netherclift; Sgt. A. Newbould; P/O. M. S. Nicholls; Cpl. H. W. Nudds; Sgt. J. O'Donnell; A/C.2 R. G. Ogg; L.A/C. J. E. Oran; F/O. M. Parry; A/C.1 J. Patterson; A/C.2 R. A. Phipps; Sgt. J. M. Pilbeam; A/C.2 L. W. Pitblado; Sgt. B. G. Pitt; Act. Sqn. Ldr. S. L. Portass; Flt. Sgt. J. R. Powell; P/O. F. E. Pratt; P/O. G. Pringle; Sgt. W. Puttick; A/C.1 J. J. Quill; Sgt. T. C. Quinlan; Sgt. D. R. Rawlings; A/C.2 F. W. Redgate; P/O. W. L. Rees; Sgt. L. T. Rice; A/C.1 H. Richardson; A/C.1 W. G. Richardson; L.A/C. C. A. Ripley; A/C.1 A. J. Rouse; A/C.1 W. Scrugham; A/C.1 S. Seddon; A/C.1 J. Segar; Sgt. W. C. Shepherd; Sgt. E. Short; L.A/C. P. W. H. Short; L.A/C. G. I. Simpson; Sgt. H. G. Simpson; Sgt. P. D. Simpson; Sgt. G. R. Slater; Sgt. R. W. Smale; Sgt. A. M. Smith; L.A/C. D. A. Smith; L.A/C. E. C. Smith; Sgt. G. A. Smith; A/C.1 H. W. Smith; Sgt. L. A. Soutar; P/O. W. McN. Spiers; A/C.1 N. Spurrier; P/O. J. Still; Sgt. P. Stocks; L.A/C. G. S. Sullivan; Sgt. G. Summers; A/C.1 S. Swatton; Sgt. J. Tague; Sgt. A. G. Tatham; Sgt. C. Tatton; L.A/C. E. Thomas; Cpl. C. Thompson; Act. Sqn. Ldr. H. F. Thomson; A/C.2 H. F. Thornton; P/O. R. V. Truemas; L.A/C. K. Turner; Sgt. R. J. Turner; Sqn. Ldr. E. A. Verdon-Roe; L.A/C. B. G. Wakefield; A/C.2 T. W. Walker; Sgt. W. H. Walker; Cpl. G. F. Walters; F/O. W. F. Ward; F/O. S. P. Watkins; Sgt. W. Watson; Cpl. E. Watt; A/C.2 R. W. Webber; P/O. H. H. Wells; Sgt. A. R. N. Whitcher; F/O. E. C. Whitehead; L.A/C. J. G. Whitlock; Sgt. N. H. Whittaker; A/C.1 V. S. H. Wigg; A/C.1 J. P. Williams; Sgt. L. C. Williams; Sgt. N. F. C. Williams; A/C.1 R. Williams; Sgt. A. W. Wilson; Sgt. B. Winchester; Sgt. A. Windle; P/O. G. P. Wise, D.F.M.; L.A/C. F. A. Woodford; A/C.1 C. L. Woods; Cpl. R. H. R. Wrighton; Sgt. W. H. Wyatt.

MISSING, BELIEVED KILLED ON ACTIVE SERVICE (WHILE ENGAGED ON NON OPERATIONAL FLYING DUTIES OR ON THE GROUND, THROUGH

WING CDR. JOHN GILLAN, A.F.C., D.F.C. is missing after a daylight sweep. Wing Cdr. Gillan commanded No. 111 Squadron when it had the honour to be the first squadron to be equipped with eight-gun Hurricanes.

ATLANTIC ANSWER. The Germans began the Battle of the Atlantic but we are beating them at their own game and their shipping losses now greatly exceed ours. This torpedo will make another big hole in enemy shipping.

SERVICE AVIATION

ENEMY ACTION).—Sgt. C. W. Bonser; Sgt. W. J. Spicer.

KILLED ON ACTIVE SERVICE.—P/O. P. Alderson, D.F.M.; Sgt. N. W. Appleby; Sgt. G. E. Appleton, D.F.M.; Flt. Lt. K. F. Arnold, D.F.C.; L.A/C. R. C. Ballard; Flt. Sgt. A. H. D. Batty; Sgt. D. O. Beacham; Sgt. A. H. Bell; Sgt. R. G. Bradley; Sgt. H. C. G. Brook; P/O. W. B. Cairns; Flt. Lt. J. E. Carter; Sgt. C. G. A. Christy; A/C.1 A. D. Clark; Sgt. T. E. Comins; P/O. N. A. Cooper; Sgt. F. Corlett, D.F.M.; A/C.2 W. Cottom; Sgt. G. A. Crompton; A/C.1 G. Edwards; P/O. M. Forster; Sgt. A. Forsythe; F/O. A. D. Frampton, D.F.C.; F/O. H. T. Gilbert, D.F.C.; Flt. Lt. M. A. Goodwin; Sgt. A. H. Green; Sgt. P. G. Griffiths; A/C.1 C. Hall; Sgt. O. Hall; Sgt. W. Harrison; A/C.1 J. Hayes; Sgt. R. Henderson; Sgt. D. W. Hughes; Sgt. H. S. Jacques; A/C.1 T. B. Jeffcote; Sgt. A. H. A. Johnson; Sgt. B. Jones; Sgt. P. Keast; Sgt. L. B. E. Larsen; Sgt. R. H. Laurie; Sgt. G. M. Le Blanc Smith; Flt. Sgt. E. R. Lines; Sgt. J. H. McInnes; Sgt. I. R. Macintosh; Cpl. P. G. Mansell; A/C.1 W. T. Mansfield; Sgt. E. J. Matthews; Sgt. A. C. Mew; L.A/C. R. A. A. Miskimmin; Sgt. R. C. A. Muir; Sgt. G. S. Parry; P/O. A. Paterson, D.F.C.; Sgt. E. W. J. Polden; Sqn. Ldr. H. C. Pugh; Sgt. P. S. Pugh; A/C.2 E. S. Redding; Sgt. C. F. Richards; A/C.1 J. Scarboro; P/O. F. H. Schumer; Sgt. K. J. Seaman; Act. Flt. Lt. J. W. Smith; Sgt. R. Smith; Sgt. A. R. Smither; Sgt. J. N. Snowden; Sgt. E. Snuggs; Sgt. H. Soar; Flt. Sgt. E. E. Sturgeon; P/O. C. F. Sutcliffe; Sgt. H. G. Turner; L.A/C. L. G. Washington; Sgt. R. E. Woolston; Sgt. E. Young; L.A/C. J. K. Young.

PREVIOUSLY REPORTED MISSING, BELIEVED KILLED ON ACTIVE SERVICE, NOW PRESUMED KILLED ON ACTIVE SERVICE.—L.A/C. E. G. Halliday.

PREVIOUSLY REPORTED MISSING, NOW PRESUMED KILLED ON ACTIVE SERVICE.—A/C.1 A. C. Fleming; L.A/C. D. G. Kemp; Sgt. F. J. L. Nicholas.

PREVIOUSLY REPORTED MISSING, BELIEVED KILLED ON ACTIVE SERVICE, NOW REPORTED KILLED ON ACTIVE SERVICE.—Cpl. H. G. Johnston.

WOUNDED OR INJURED ON ACTIVE SERVICE.—Flt. Lt. N. G. Birks; L.A/C. B. Christison; L.A/C. S. R. Dean; Act. Flt. Lt. T. A. Freke; Sgt. L. A. Leetham; Sgt. H. Murdock.

DIED OF WOUNDS OR INJURIES RECEIVED ON ACTIVE SERVICE.—Sgt. B. W. Hopton; A/C.1 F. G. Miles; L.A/C. G. E. Papworth; Sgt. W. Seaton.

DIED ON ACTIVE SERVICE.—A/C.1 R. Faulkner; Cpl. K. G. Gilbrey; Cpl. A. B. Goldie; L.A/C. F. S. Holleway; L.A/C. W. R. Hunnam; Act. Cpl. E. J. Macdonald; Cpl. L. D. W. Miller; A/C.1 K. Ollier; Sgt. A. Ramsden; L.A/C. L. A. Smith; L.A/C. T. F. Spiby; A/C.2 W. G. Talbot; A/C.2 R. L. Yeats.

SEALED BEFORE DELIVERY: The muzzles of a fighter's guns are sealed against rain and other "foreign matter" before taking-off and the first round "delivered" removes this covering. This R.A.F. armourer is covering the business end of a Spitfire's shell gun.

PREVIOUSLY REPORTED MISSING, NOW DIED ON ACTIVE SERVICE.—Act. Wing C/r. W. J. B. Elliott.

PREVIOUSLY REPORTED MISSING, NOW REPORTED SAFE.—P/O. H. P. Duval.

PREVIOUSLY REPORTED MISSING, BELIEVED KILLED ON ACTIVE SERVICE, NOW REPORTED PRISONER OF WAR.—Sgt. W. G. S. Austin; L.A/C. C. F. Quilliam.

PREVIOUSLY REPORTED MISSING, NOW REPORTED PRISONER OF WAR.—Cpl. D. E. Buchanan; F/O. A. R. Butcher; L.A/C. D. R. Cherry; A/C.1 B. W. Collett; F/O. T. H. Cullen; P/O. H. N. MacP. Daston; F/O. C. N. Dilly; A/C.2 G. D. M. Dow; Flt. Lt. C. H. Fry; A/C.1 S. C. Hogg; Sqn. Ldr. E. A. Howell; Flt. Lt. C. R. C. Howlett; Sgt. F. H. Leveridge; A/C.1 B. Lewis; A/C.1 H. W. Longbottom; A/C.2 H. Lye; Flt. Lt. P. Mason; A/C.1 E. G. Pendegrass; Sgt. D. A. Phillipson; Sgt. E. W. Pickering; L.A/C. L. C. Wilkinson; L.A/C. D. M. Williamson.

AMENDMENT TO PRESS COMMUNIQUE No. 78.—KILLED ON ACTIVE SERVICE: *For* Act. Sqn. Ldr P. S. Hutchinson read Sqn Ldr. P. S. Hutchinson.

Royal Australian Air Force

DIED OF WOUNDS OR INJURIES RECEIVED IN ACTION.—Sgt. R. S. Wallwork.

WOUNDED OR INJURED IN ACTION.—Sgt. H. L. Fyfe.

MISSING.—Act. F/O. R. B. Campbell; Sgt. J. A. Cormack; Sgt. S. T. Flowers; Sgt. M. R. Ross.

KILLED ON ACTIVE SERVICE.—Sgt. C. C. Astenfeld; Sgt. J. Neal; Sgt. K. T. Robertson.

PREVIOUSLY REPORTED MISSING, NOW REPORTED PRISONER OF WAR.—P/O. N. M. Dunn.

Royal Canadian Air Force

KILLED IN ACTION.—Sgt. J. D. Evelle.

DIED OF WOUNDS OR INJURIES RECEIVED IN ACTION.—F/O. P. W. Lochman.

MISSING, BELIEVED KILLED IN ACTION.—Sgt. O. I. Platt.

MISSING.—Sgt. J. C. Crump; Sgt. H. W. Fish; P/O. C. D. Hewson; Sgt. J. E. Jamieson; Sgt. A. J. Lassner; Sgt. J. L. Martin; Sgt. W. Owen; Sgt. G. A. Prosser; Sgt. J. G. Rogers; Sgt. G. H. Tett; Sgt. W. F. Towlson.

MISSING, BELIEVED KILLED ON ACTIVE SERVICE.—Sgt. K. F. Druhan; Sgt. M. G. Wilson.

KILLED ON ACTIVE SERVICE.—P/O. W. H. Arnold; Sgt. W. J. Chevers; Sgt. G. D. Dodds; Sgt. S. G. Dunn; Sgt. G. E. Fleming; Sgt. L. German; Sgt. A. S. Hemphill; Sgt. W. H. Hindle; Flt. Lt. G. C. Hyde; Sgt. E. R. Kennedy; A/C.1 F. W. Kidd; Sgt. J. F. Macmillan; P/O. J. M. Milmine; Sgt. R. M. Murray; Sgt. M. A. Plomteaux; Flt. Lt. W. A. Rider; Sgt. R. G. Smith Sgt. J. C. Sleeves; Sgt. G. Stevenson; Sgt. C. L. Vance; Sgt. H. B. Webster; Sgt. W. A. Womack.

DIED OF WOUNDS OR INJURIES RECEIVED ON ACTIVE SERVICE.—Sgt. G. C. Bingley; Sgt. M. E. McMurdo.

DELETE FROM PRESS COMMUNIQUE No. 78.—Act. Flt. Lt. R. B. Barr.

Royal New Zealand Air Force

MISSING, BELIEVED KILLED IN ACTION.—Sgt. A. W. P. Bird.

MISSING.—P/O. D. Brook; Sgt. J. A. Grady; P/O. M. Jolly; P/O. D. A. Lewis; Sgt. J. Maney; Sgt. C. H. Robson; Sgt. A. D. Scott; Sgt. D. F. Streeter; Sgt. G. S. Walker; Sgt. I. F. Waugh; Sgt. G. Wells.

KILLED ON ACTIVE SERVICE.—Sgt. W. Fleming; Sgt. I. N. Robinson.

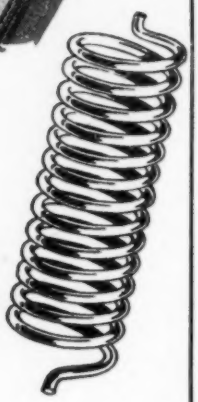
South African Air Force

MISSING, BELIEVED KILLED IN ACTION.—2/Lt. C. C. Gordon; Air Sgt. R. E. O. Giles; Air Sgt. P. W. D. B. Bothma.

KILLED ON ACTIVE SERVICE.—Act. Sgt. U. C. Adams; Act. Sgt. S. W. Bowley.

DIED ON ACTIVE SERVICE.—Lt. P. D. Anneck-Hahn.

THEY'LL SHOOT FIRST IN FUTURE: These five American airmen in R.A.F. uniform, snapped in London, are the survivors of a party of 11 who were torpedoed in the Atlantic on their way here to volunteer. They were rescued by a Polish warship after clinging to wreckage for 12 hours, but they'll soon have their chance to "shoot first."



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BECAUSE this customer asked for our advice on his Spring problem before even completing his machine designs, we were able to save him a lot of time and to produce for him a safely stressed spring on which he could absolutely rely.

Spring designing is a skilled job, and our accumulated experience of nearly 87 years is freely at your disposal. So take advantage of it as early as possible when developing your new production.

When all's said and done, the spring is the heartbeat of most machines, and if you want to be sure of maximum efficiency, our Research Department is waiting to serve you.

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Chats

BY THE 'MAJOR'

No. I. ON PETROL COCKS

Taking poison to discover the consequences is an antiquated mode of scientific research. It may have contained an element of humour for him who watched but none for him who stood and waited.

Nor can we afford to crash planes from 40,000 ft. in an effort to find the answer to the seizing of petrol cocks at high altitudes. Luckily, the science of engineering is less empirical than toxicology. We have a few guiding principles and more appliances.

A first essential in a petrol cock is that it be turned on and off easily; the operational effort must be the minimum compatible with petrol tightness. By dint of much patience and many patents, we perfected a mechanism to operate at 12 inch lbs. at ordinary room temperatures. Then, instead of going up, we went down. Using a freezing mixture, we took the temperature of the petrol cock down to −10°, −20°, −30°, −40°, −50° Centigrade. The operational effort needed to turn the cock rose sharply to 60 inch lbs. at −40° C. At −50° C. the cock completely seized; the effort needed to turn it was beyond the capacity of the apparatus, 150 inch lbs.

Thereupon, the problem was referred to our enthusiastic if somewhat shaggy metallurgist. For once we did not have long to wait for an answer. For once it was the correct answer. This time the operational effort at −50° C. was only 17 inch lbs. i.e. well below the maximum effort of 30 inch lbs. which it is estimated a pilot with gloved hands can exert.

It was a matter of using the right metal in the right place and in the right way. Simple, isn't it?

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